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COLD WEATHER ENVIRONMENTAL GROUND STARTING TEST USING JP-8 IN E--ETC(U)
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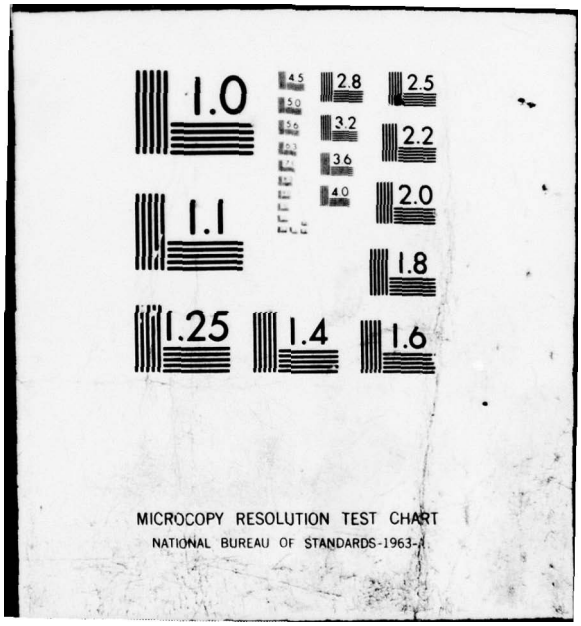
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ODGEN AIR LOGISTIC COMMAND
HILL AFB UTAH 84406

(6) COLD WEATHER ENVIRONMENTAL
GROUND STARTING TEST
USING JP-8 IN EGLIN
CLIMATIC CHAMBER,

(9) Rept. for 12 Jun - 18 Aug 78,

(11) DATE: 25 Octe[redacted]978

(10) PREPARED BY
TOMIO MITSUNAGA
Tomio Mitsunaga

(12) 84 pp

TEST CONDUCTED BY
MMIRAM

Franklin Alef
SECTION CHIEF

Lt. Richard B. Mazil
SAFETY OFFICER

BRANCH CHIEF

400 064

FORWORD

This report covers ground starting test of F-4 aircraft in the Eglin climatic chamber as directed by HQ AFLC, in compliance with USAF/LGY Project Directive PDM L-Y 8026 (1), 14 February 1978.

The following personnel were directly involved in the test program:

Test Director	Mr Tomio Mitsunaga	OO-ALC
Assist Test Director	Mr Steve Ruedy	OC-ALC
Advisor	Mr Ron Lanning	General Electric
ADTC Test Coord	Mr Art Goolsby	Eglin
ADTC Project Eng	Mr Ray Stark	Eglin
Crew Chief, F-4D	S/sgt Robert Haney	McDill
Crew Chief, F-4D	S/sgt Douglas Tyler	McDill
Crew Chief, F-4E	T/sgt Dan Roy	Homestead
Engine	S/sgt Davies	Eglin

There were many more who were involved in making the ground start test a success but due to space available all the names could not be listed. The assistance provided by the people who participated directly or indirectly in the F-4 cold weather starting test at Eglin AFB FL, during 12 Jun-18 Aug 78, was essential in completing the test in a timely manner.

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ABSTRACT

The purpose of the ground test was to determine if there was any degradation to the F-4 ground start during cold weather with the aircraft serviced with JP-8 fuel. Also, several proposals for improving the F-4 low temperature starting capability were tested. Various combinations of fuel, JP-4 and JP-8, and engine specific gravity settings, .78 and .82 were tested to simulate actual field situations. Based on the test results the following conclusions were made:

1. With the aircraft serviced with JP-8 and the fuel control specific gravity at .82, the two F-4 aircraft used in the ground start test were able to start as low as -40° F. The only starting degradation noted was the longer time required for the engine to reach idle RPM. At no time did the engine exhaust gas temperature (EGT) exceed the maximum allowable temperature.

2. The modified liner and High Energy Ignition System (HEI) modification did not improve the F-4 starting characteristic.

3. With the aircraft serviced with JP-4 or JP-8 and the fuel control specific gravity set for .78 (setting for JP-4) or .82 (setting for JP-8), the various combination of fuel and specific gravity settings did not adversely affect the cold weather starting capability of the F-4 aircraft.

CONTENTS

INTRODUCTION

We have been informed by HQ USAF that NATO countries will be converting from JP-4 to JP-8 fuel. Indications are that in 1979 F-4 aircraft receiving fuel in the United Kingdom will be serviced with JP-8. Prior to this date, F-4 aircraft performance and operation when using JP-8 must be investigated and any adversity noted must be annotated in applicable tech orders. Presently the aircraft flight performance is being tested at Air Force Flight Test Center (AFFTC) Edwards AFB CA. Another area of concern is the cold weather starting capability of the F-4 aircraft. Limited testing that had been conducted at Grand Forks AFB ND indicated that F-4E would not start consistently below +40° F. Because of the restricted starting capability of the F-4E aircraft found at Grand Forks, several ideas for improving the F-4E starting capability were suggested. HQ AFLC requested Ogden ALC with OC-ALC assistance to test two F-4 aircraft with two different model engines, J79-15 and -17, in the Eglin climatic chamber to determine the minimum starting temperatures under temperature controlled conditions. Furthermore, Ogden ALC was requested to investigate other proposals of improving the starting capability of the F-4 aircraft. The specific objectives for the cold weather ground starting test were as follows:

a. Determine minimum starting temperature of the F-4 aircraft utilizing JP-8 fuel with engine main fuel control specific gravity set for .82 for the following engine configuration:

(1) Engine using standard combustion liner and standard ignition system.

(2) Engine using modified combustion liner (closed off louver) and standard ignition system.

(3) Engine using high energy ignition (HEI) system and standard combustion chamber.

(4) Engine using HEI and modified liner.

b. Determine the starting characteristic of the F-4 aircraft utilizing JP-8 fuel with specific gravity set at .78 (JP-4 fuel setting). The engine is to be configured for standard ignition and combustion chamber.

c. Determine the starting characteristic of the F-4 aircraft utilizing JP-4 fuel with main fuel control specific gravity set for .78 and .82.

DESCRIPTION

AIRCRAFT:

Two aircraft were provided by HQ TAC for our ground start test (see Figures 1 and 2). The two aircraft selected for our program were F-4E, S/N 68-450, and F-4D, S/N 66-478. The aircraft had the following engines and starters installed:

F-4E

RH Engine J79-17, S/N 453489, 559.1 since last overhaul and had just completed 600 PE. Total engine time was 1787.1 hours. AiResearch starter, S/N P5880, was 0 time starter.

LH Engine J79-17, S/N 430911, 00 hours since last overhaul. Total engine time was 2223.8 hours. Sundstrand starter, S/N 1840, was 00 time starter.

F-4D

RH Engine J79-15, S/N 434353, 106.2 hours since last overhaul. Total engine time was 2140 hours. AiResearch starter, S/N P16813, had 398 hours since last overhaul.

LH Engine J79-15, S/N 420044, 00 hours since last overhaul. Total engine time 3517.7. Sundstrand starter, S/N 345, had 300 hours since last overhaul.

FUEL

The arrangement of JP-8 for our test was made by HQ AFLC. The analysis of the fuel is included in Appendix V.

CARTRIDGES, MXU-4A

The cartridges were obtained through normal supply channels. All the cartridges were made by Olin Mathieson and were from the same lot number, OL12-36.

PNEUMATIC GROUND CART

The pneumatic air used for starting came from M32A-60 ground cart. Later the M32A-60 was replaced by a MA-1A cart which was easier to move and maintain.

MONITORING EQUIPMENT

Magnetic tape recorder, PDP11/45 computer and textronex copier 4023 CRT were used to monitor and record the ambient temperature of the chamber, fuel manifold temperature, engine RPM and engine starter pressure.

FIGURE 1. GENERAL VIEW OF F-4E TEST AIRCRAFT IN EGLIN CLIMATIC LAB

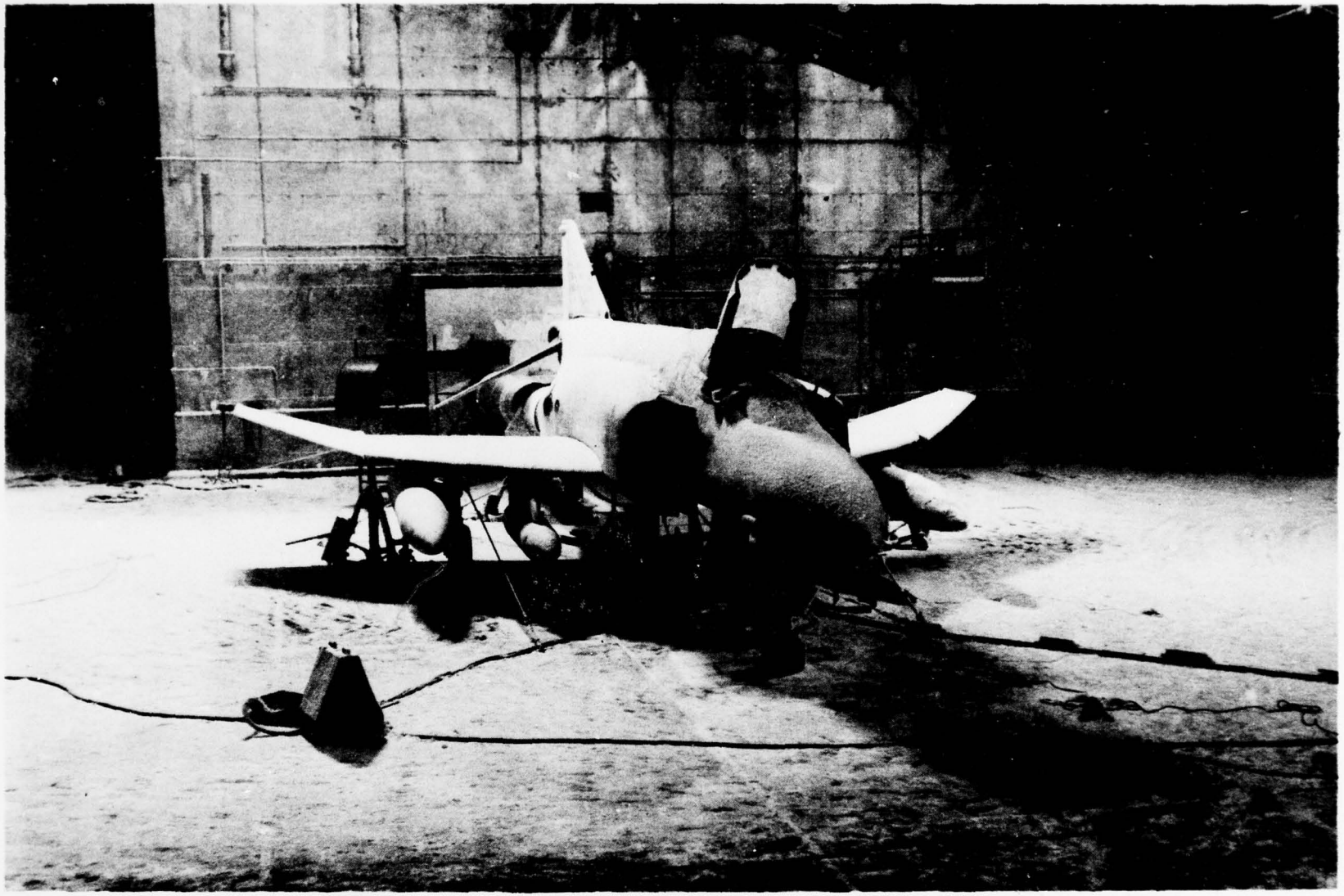


FIG 2 GENERAL VIEW OF F-4D TEST AIRCRAFT IN EGLIN CLIMATIC LAB

PREPARATION AND TESTING

GENERAL:

The ground starting test runs were conducted in accordance with the basic ground start test directive in appendix I and as directed by the test director. It was recommended that the aircraft be cold soaked for minimum of 12 hours to insure the fuel and engine temperature are at the desired temperature, however, we were forced to make two starts per day (cartridge start in the morning and a pneumatic start in the afternoon) because we were limited in time and money. This procedure did insure that for a cartridge start we had adequate cold soak time, (minimum of 17 1/2 hours). The soak time for pneumatic start was considerable less than the recommended time. The average time was around 5 1/2 hours. It was felt that if a cartridge start could be made, there was no doubt a pneumatic start could be made at that same temperature. In several cases where we were unable to make a cartridge start in the morning, we made the cartridge start in the afternoon and deleted the pneumatic run for that temperature. If the cartridge start had failed, we would of changed our schedule and made a pneumatic start the next day, however, we were never forced to make a pneumatic start the next day.

The two aircraft, F-4E, S/N 68-450 and F-4D, S/N 66-478, were provided by TAC for the test program. TAC also made arrangements to provide crew chief, engine mechanic and observers. Prior to starting the cold weather start test, the engines from the two test aircraft were removed and modified with high energy ignition (HEI) system on the RH engine in the number 4, combustion chamber. Also, a modified combustion liner (closed off louver) was installed in all 4 engines in place of the existing number 4 combustion liner. By pulling the circuit breaker for ignitor plugs in either number 4 or 5 combustion chamber or moving the ignitor plug with the HEI from chamber number 4 to the chamber number 5, we were able to test the engine in the various configuration; standard (standard combustion liner and standard ignition system), HEI (standard combustion chamber and HEI ignition system). Modified liner (modified combustion chamber and standard aircraft ignition system) and HEI with modified liner (HEI ignition system and modified combustion chamber).

After the engines had been modified they were sent through the test cell, installed in the aircraft and retested at the trim pad. No major problems recorded. Then the aircraft were defueled and bucket drained. Next the aircraft were refueled with JP-5 and operated for a short interval to purge the fuel control of JP-4. Again the aircraft was defueled and bucket drained. Finally the aircraft was serviced with JP-8. Fuel samples from number six fuel cell drain, engine fuel feed line, fuel drain in door 22 and wing tanks were taken. The fuel samples indicated the flash point were around 106o F which was close to the flash point of the stored JP-8 fuel.

The aircraft tie down was designed and installed by ADTC personnel in the climatic chamber. Figure 3 shows how the tie down was accomplished. The aircraft were placed on jackets and tie down cables were used to secure the aircraft. It was imparative that the aircraft did not move during engine run, because of the close clearance between the engine exhaust and the chamber exhaust duct. The aircraft was operated at MIL power and only minimal amount of aircraft movements were noted.

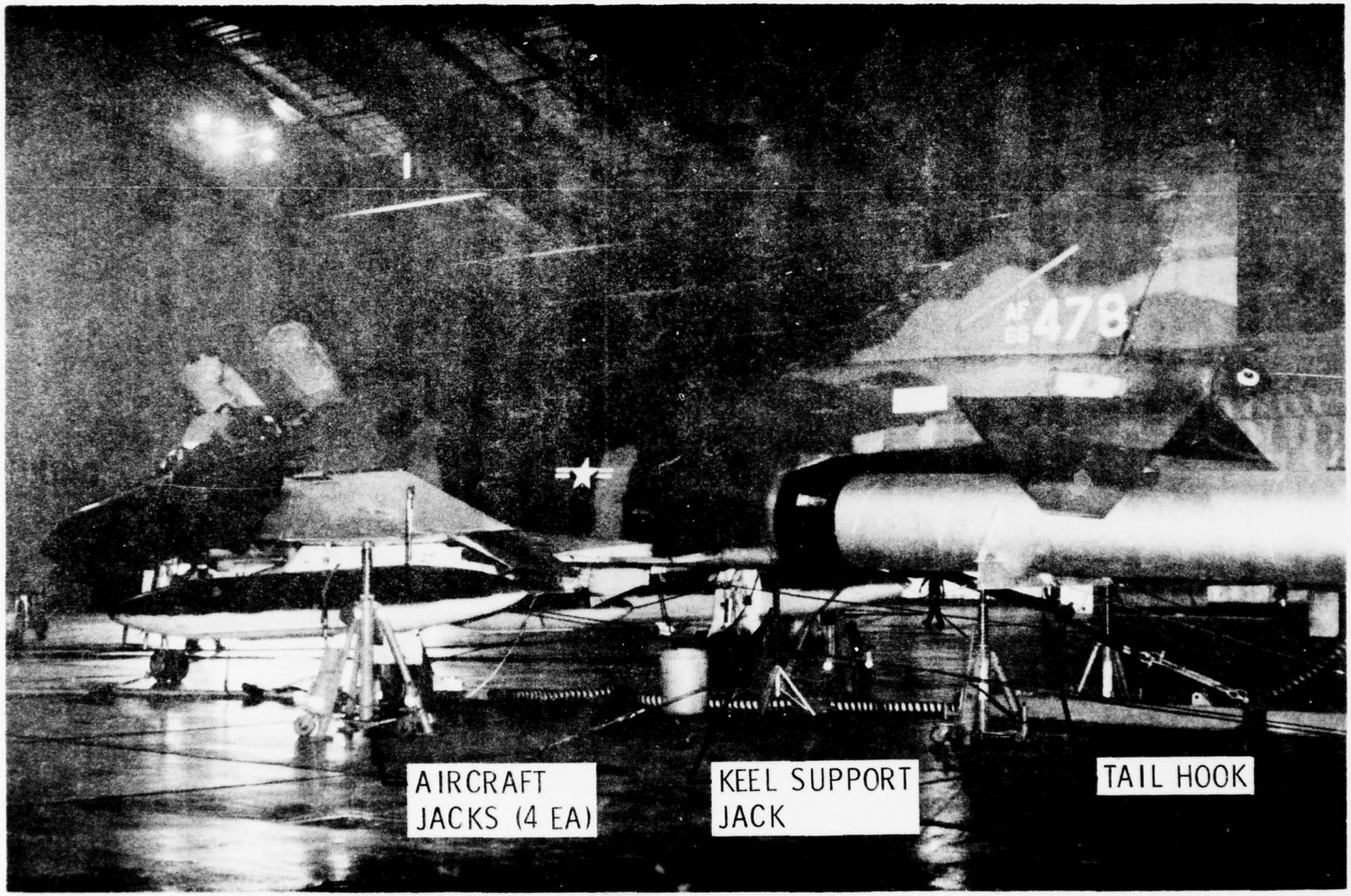


FIGURE 3. GENERAL VIEW OF TIE DOWNS AND JACKS

Due to the short time to prepare for the test program, we limited ourselves to the number of test points to be monitored. The instrumentation was installed by ADTC personnel. The test points we requested to be monitored were as follows:

1. Engine RPM

2. Starter pressure

3. Engine fuel manifold temperature

4. Aircraft nose temperature (climatic temperature)

The instrumentation wiring were run from the aircraft to the signal conditioner in the control room which was located in the climatic chamber. The signal was then transmitted to the magnetic tape recorder in the computer room and then back down to the control room on a video scope and textronix copier 4023 CRT. The process data was displayed in real time on a textronix 4023 CRT and copier. A textronix copier was used for an instantenous record of the test parameter which proved extremely useful for on-the-spot evaluation/ comparisons between runs (figure 4).

Initially the M32A-60 pneumatic air cart was used to furnish the pneumatic air for starting and aircraft external electrical power. As the climatic chamber temperature was lowered, it became difficult to move the air cart from one aircraft to the other. Also it was difficult to keep in operating condition. Since we were not required to test the M32A-60 cart, it was decided that the -60 cart would be replaced by the electrical power from the lab and MA-1A cart for pneumatic air. The MA-1A was much smaller and easier to handle. To insure the cart would operate during the test, it was kept outside until it was time to start the aircraft.

The pilots from TOC/Eglin AFB were used during the cartridge starts in accordance with Air Force regulation. A total of four pilots were utilized through out the test program. Efforts were made to keep the number of pilots to a minimum to standardize pilot operating technique but due to TOC flying schedule we had to use the pilots that were available, however, each new pilot was indoctrinated to move the throttle and press the ignition button approximately five seconds before moving the start switch. All pneumatic starts were performed by the crew chiefs for the applicable aircraft. Starting technique was in accordance with the tech order.

The cartridges, MXU-4A were stored in a room outside of the climatic chamber. At the end of each cartridge start run, five cartridges were placed in a pre-selected area in the climatic chamber for cold soaking. An extra cartridge was cold soaked in case of a cartridge malfunction there would be an immediate cartridge replacement available. The cartridges were removed from the container just prior to making a cartridge start. All safety requirements were adhered to at each cartridge start. There was a fire truck stationed outside of the climatic chamber for immediate response. Fire guards were located around the aircraft as well as a fire guard stationed outside near the engine exhaust. There was a guard stationed at the V door whose responsibility was to open the door for the fire truck in case of fire.

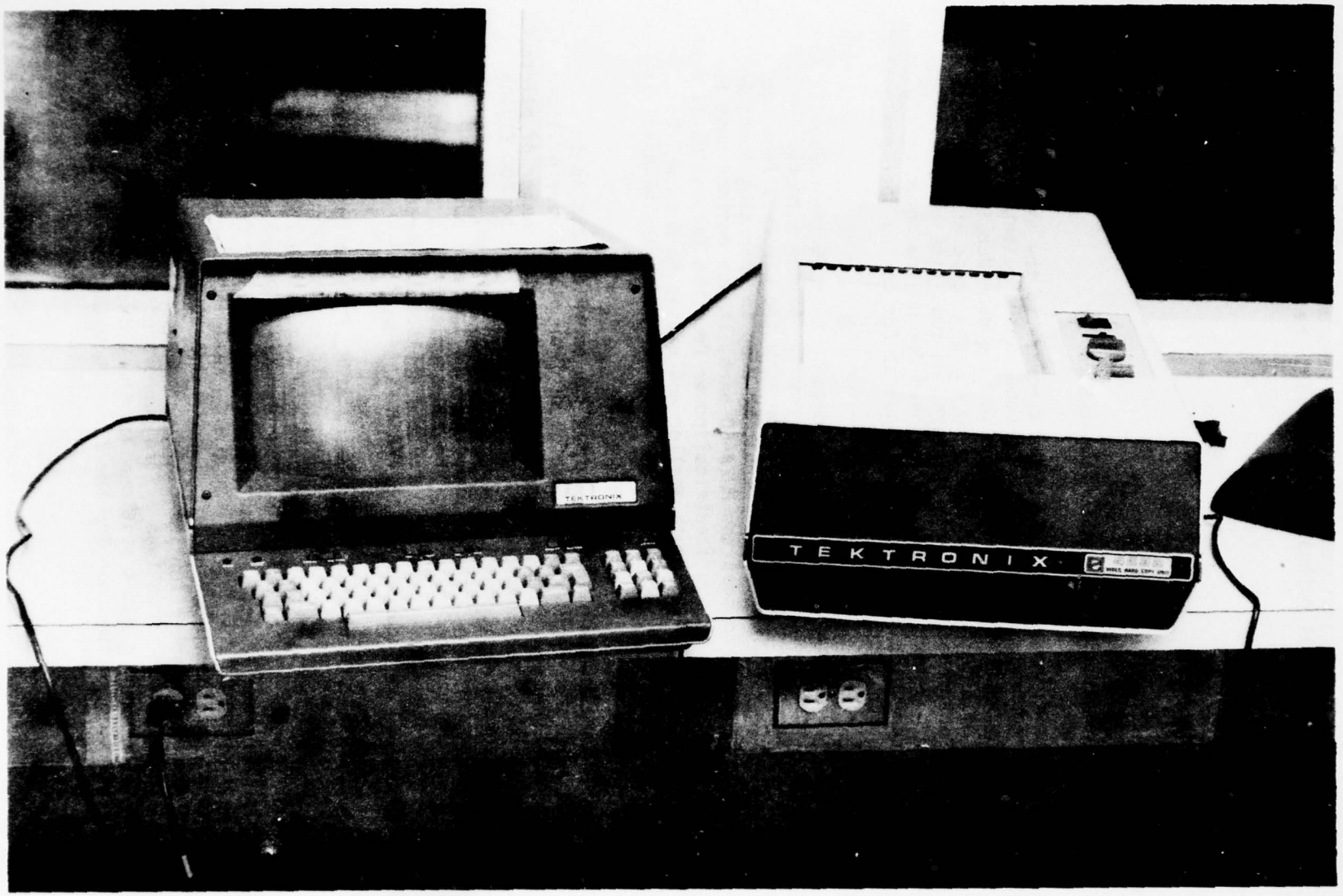


FIGURE 4. TEXTRONIC 4023 CRT COMPUTER AND COPIER

TEST RESULTS

JP-8, SG 0.82 STANDARD ENG CONFIGURATION.

The first series of runs were made with the aircraft fueled with JP-8 and specific gravity (S.G.) set at 0.82 (a value selected for JP-8). (Run 1-9 and 13.) The engines were configured for standard configuration. This would simulate a field condition if we were to service a F-4 aircraft with JP-8 today. The only difference would be that in our test we operated with only one ignitor plug in each engine. Normally two ignitor plugs are fired simulantenously, therefore, as long as we are able to start the engines in climatic chamber, we were more confident that a start could be made in the field using two ignitor plugs.

The climatic lab temperature was started at +40° F and was lowered at increments of 10° F to -40° F (run No 1 thru 9 and run No 13)(see Appendix II, III and IV). In several instances, the aircraft failed to start or reach idle RPM. These failures were not attributed to JP-8 fuel but due to aircraft component failures, e.g., defective breech cap, stuck throttle mirco switch, and frozen starter switches. These type of failures were most noticable at -40° F. We attempted to make a cartridge start at -40° F twice (run # 9 and 13) and in each case two out of four engines failed because of component malfunction or failure. At this temperature, the engine start time increased to 116, 121, 128 and 113 seconds. At no time did the engine EGT exceed maximum allowable limits.

JP-8, SG .78, STANDARD ENGINE CONFIGURATION

Since we were able to start the engine at -40° F with the engine in standard configuration we modified the existing test plan. We felt there was no need to raise the climatic chamber temperature back up to +40° F for each series of test runs. This would be costly and time consuming therefore, we elected to just test each of new conditions at -10° F, -20° F and -30° F. For run 10, 11 and 12 we changed the SG 0.78 to simulate a condition in the field where JP-8 was serviced for the first time and the main fuel control SG was not changed. A faster starting time was recorded during these run in the cartridge mode. The time ranged from 33 to 65 seconds for F-4E and 32 to 43 seconds for F-4D. For some unknown reason at -20° F, the fastest starting time was recorded for F-4E aircraft for this run.

JP-8, SG 0.82 RH ENGINE - MODIFIED LINER AND HEI; LH ENGINE - MODIFIED LINER

By resetting the number 1 circuit breaker (C/B) and pulling the number 2 C/B, the ignitor plug in the number 4 chamber, this would test the modified liner with HEI on RH engine and modified liner on LH engine. This was accomplished on run 14, 15 and 16. Here again the F-4D aircraft consistently started faster than F-4E aircraft in cartridge and pneumatic mode of starting. At -30° F the starting time increased significantly. In cartridge mode for F-4E aircraft the time was approximately 100 seconds while F-4D aircraft start time was 82 and 43 seconds. In pneumatic mode the start time was from 50 to 62 seconds at temperatures of -20° F and -30° F. (See Appendix V for start time)

JP-8, SG 0.82, HEI ON RH ENGINE, STANDARD ON LH ENGINE

In this test we switched the #4 ignitor plug (connected to the HEI) with the ignitor plug #5 in only the RH engine. By pulling the C/B #1 on the RH engine and pulling the C/B #2 on the LH engine we test the HEI on RH engine and standard configuration on LH engine. This was accomplished on run 17, 18 and 19. However, we failed to pull the C/B #2 on LH for the first run at -10° F. This resulted in the engine being tested with a modified liner. On run 18 we corrected the error. Here again we made cartridge and pneumatic starts at -10° F, -20° F and -30° F with no problems. As the temperature was lowered, the starting time for F-4E aircraft was 60 seconds LH, 46 second RH at -10° F, 81 and 57 seconds at -20° F, and 89 and 87 seconds at -30° F. The F-4D aircraft start time was 33 and 41 seconds at -10, 43 and 39 seconds at -20° F, and 90 and 54 second at -30° F. In pneumatic mode the starting time ranged from 47 to 56 second for both aircraft for temperatures at -10°F and -20° F.

JP-4, SG .78, ENGINE STANDARD CONFIGURATION

The aircraft was defueled and refueled with JP-4 without moving the aircraft out of the hangar. All safety precautions were adhered to, to insure safe operation. These series of runs were made for the purpose of getting a base line for JP-8 to be compared with. The ignitor plugs in the RH engines were interchanged again. By pulling the #1 C/B, the engines were tested in the standard configuration. The start times (run No 20, 21 and 22) were consistently faster in both cartridge and pneumatic mode, in fact at -30° F the start time did not increase significaty over start times at -20° F. With JP-8 as the temperature got lower, the time increased considerably but not with JP-4. The average start time using JP-4 at -10° to -30° F for F-4E aircraft was 41 seconds and for F-4D was 32 seconds. In pneumatic starting mode, the starting time ranged from 44 to 56 seconds for F-4E aircraft and 40 to 46 seconds for F-4D aircraft.

JP-4, SG .82, ENGINE IN STANDARD CONFIGURATION

In this series of test we changed the SG to .82 with the aircraft serviced with JP-4. Test results showed no noticeable degradation in start time in run 22 and 23 at temperatures -20° F and -30° F when compared with run 21 and 22. The average start time for F-4E aircraft was 41 seconds and F-4D was 35 seconds at -20 and -30° F. In pneumatic mode the starting times were 45, 47, 43 and 48 seconds at -20° F. No other runs were made in the pneumatic mode.

CONCLUSION

JP-8, SG .82, STANDARD ENGINE CONFIGURATION

The test results showed that the two test aircraft, F-4E and F-4D were able to start as low as -40o F. Several times the aircraft failed to start or attain idle RPM but the failures were not attributed to JP-8 fuel. The failures were due to aircraft component or ground support equipment malfunction. The test results indicated that the F-4 aircraft can be started using JP-8 at temperature as low as -40o F, however, the pilots should be made aware that the start time may drag out to 125 seconds. In many of the long start times, it appears the engine had a hung start with very little change in RPM. With our video scope we were able to tell that the RPM was either decreasing or increasing even though it was a small amount. A pilot would have a difficult time reading his RPM guage to note the small change in RPM. Recommend as long as the engine EGT does not exceed maximum allowable limit, the pilot should not terminate a start immediately even though it appears the engine has a hung start. The pilot should wait approximately 30 seconds before terminating the start.

Even though the aircraft was not cold soaked properly (a minimum of 12 hours) for the pneumatic run, we are confident that the F-4 aircraft can be started in the field as low as it did in our test, -40o F. This is based on the fact that we were able to make cartridge starts at that temperature.

JP-8, SG .78, STANDARD ENGINE CONFIGURATION

The field should not have any problems in starting the F-4 aircraft in cold weather when the aircraft is serviced with JP-8 and SG set at .78. The start time improved when the specific gravity setting was changed from .82 to .78, however, even with the faster starting time the pilots will experience what appears to be a hung start. By waiting approximately 30 seconds before terminating a ground start many of the aborted starts can be eliminated, if not all. In our test we never experienced any hung starts.

In the pneumatic mode at -10o F, the start time ranged from 75 to 97 seconds but as the temperature was lowered, the start time ranged from 44 to 53 seconds which was typical of other starting times. Examination of the test data revealed that the long start time coincided with a long delay in engine ignition time. On both aircraft, the engine ignition time took 50 to 60 seconds. Due to our limited instrumentation, we have no explanation for the long delay in ignition time.

JP-8, SG .82, ENGINE CONFIGURATION - MODIFIED LINER, HEI AND MODIFIED LINER HEI

With only a limited number of test points it appears the various modification to the engine, (HEI and modified liner) did not improve or cause any degradation to the engine starting characteristic, therefore, we do not recommend incorporating the HEI or modified liner for the purpose of improving the F-4 starting characteristic.

JP-4, SG .78, STANDARD ENGINE CONFIGURATION.

The aircraft present configuration utilizing JP-4 provided the consistently faster start time except for one point at -10° F, LH engines, F-4E, in cartridge mode. The aircraft took 63 seconds to reach idle. All other starts on that same engine took between 34 to 40 seconds to reach idle RPM for temperatures between -10° F to -30° F. It is difficult to analyze why the LH engine took as long as it did for that one start. It appears to be an isolated case, otherwise, data presented, in our opinion, is a representative sample for base line data.

JP-4 SG .82 STANDARD ENGINE CONFIGURATION

Changing the SG from .78 to .82, did not change the engine starting characteristic appreciably, however, it was noted that the J79-15 engine was a faster starting engine than the J79-17 engine. This was also true throughout our test, and the test at Grand Forks in March 1978. It did not matter whether the aircraft was serviced with JP-8 or JP-4, the F-4D was a faster starting aircraft, in the cartridge mode.

RECOMMENDATIONS

1. The applicable F-4 tech orders be revised to include JP-8 as a useable fuel.

2. The modified liner or High Energy Ignition (HEI) system should not be incorporated for the purpose of improving cold weather starting performance.

3. On a hung start using JP-8, the operator should wait for 30 seconds before terminating the start provided engine EGT does not exceed maximum temperature limits.

4. After the F-4E flight test program has been completed, an evaluation should be made to determine if a common specific gravity setting can be established for JP-4 and JP-8.

5. The applicable F-4 tech orders be revised to note that when the aircraft is serviced with JP-8, the start time may extend out to 128 seconds at extreme cold temperatures.

APPENDIX I

TEST DIRECTIVE

F-4 AIRCRAFT

COLD WEATHER ENVIRONMENTAL GROUND STARTING TEST USING JP-8 IN EGLIN CLIMATIC CHAMBER

DATE: 19 MAY 1978

PREPARED BY:
TOMIO MITSUNAGA
MMIRAM

APPROVAL:

Tomio Mitsunaga /MMIRAM
PROJECT ENGINEER

Lt. R. Wotzel /MMIR(Safety)/
SAFETY OFFICER

SECTION CHIEF

BRANCH CHIEF, Maj

GROUND TEST DIRECTIVE

I. Administration Data:

a. Purpose: The purpose of the ground test is to determine if there is any degradation to the F4 ground start during cold weather starting when the aircraft is fueled with JP-8.

b. Background:

(1) We have been informed by Headquarters USAF that the NATO countries will be converting from JP-4 to JP-8 fuel. Indications are that in 1979 F-4 aircraft receiving fuel in the United Kingdom will be serviced with JP-8. Prior to this date, F-4 aircraft performance and operation when using JP-8 must be investigated to determine possible adverse affects. These adversities must then be annotated in applicable tech orders or corrected if possible.

(2) The immediate concern is to determine the low temperature starting limit in both pneumatic and cartridge starting modes. Limited testing has been conducted at Grand Forks, Air Force Base, North Dakota. These indicate that the F4E aircraft in the cartridge starting mode is limited to 40 degrees farenheit ambient temperature. Several proposals for improving the F4E starting temperature have been mentioned. These proposals will have to be investigated concurrently with the above tests.

c. Project Engineer: Tomio Mitsunaga, Ogden ALC (MMIRAM) AUTOVON 458-6322. Alternate Dan Warren, OO-ALC (MMERE) AUTOVON 735-7666.

II. RESPONSIBILITIES & EQUIPMENT:

a. Test Aircraft

An F4E (J79-17 engine) and a F4C, F4D or RF4C (J79-15 engine) shall be provided by TAC. Maintenance, handling, operation and modification of the test aircraft shall be the responsibility of TAC and Eglin test group.

b. Aircraft Ground Equipment:

All AGE required by the test aircraft shall be the responsibility of TAC and Eglin test group.

c. Starter Cartridges:

A minimum of 64, P/N MC4-4A, NSN 1377-00-062-003, cartridges will be required. An additional 10 back-up cartridges should be made available in case of defective cartridges. Cartridges shall be provided by Eglin test group.

d. Fuel:

Headquarters AFLC shall make arrangement to have the JP-8 available at Eglin, AFB for the test program. Handling, storage and dispensing of the JP-8 will be the responsibility of Eglin test group.

e. Instrumentation:

Due to time limitation imposed, the only instrumentation required is equipment to continuously monitor the surface temperature of the P/N 250515-102 manifold on each engine. Monitoring equipment shall be of the digital read out type. Accuracy within $\pm$ 2% of indicated temperature. Temperature range -40^0 thru $+ 70^0$F. Surface temperatures of manifold may be sensed at any convient location on manifold. All instrumentation including equipment, installation, maintenance and operation shall be the responsibility of the Eglin test group. Monitoring the record will be the test engineers responsibility during testing.

f. Ingnition System and Liners:

Two (2) High Engergy Ignition (HEI) systsms and four (4) modified combustion liners to modify the test aircraft for improved engine starting capabilities, shall be furnished by OO-ALC.

III. ENGINE MODIFICATION:

Engine modification and subsequent functional testing to assure quality and proper engine performance shall be the responsibility of TAC and Eglin test group. Engine modifications required are as follows:

a. The engines in both test aircraft shall have the number 1 ignitor plug chamber liner removed and replaced with a modified chamber liner.

b. The right hand engine on both test aircraft shall have the number 2 ignitor ignition system modified with HEI.

IV. SAFETY REQUIREMENTS:

a. Fire trucks will be on standby during engine start. However, the fire truck need not be at the test area but must be available for immediate response. Other ground safety equipment required for the ground start shall be available. Headphones shall be used during the ground test.

b. If the cartridges misfire, safety precautions outlined in 1F-4 (2-8) will be adhered to.

V. DISPOSITION INSTRUCTIONS:

a. At the end of the test, the aircraft will be defueled and bucket drained of all JB-8 fuel. The aircraft will be refueled with JP-4 and the engines de-modified to original configuration. Then the aircraft will be released to the using command.

b. the disposition of un-used JP-8 will be the responsibility of the Eglin test group.

c. Expended starter cartridges will be certified inert in accordance with TO 11A-1-60.

d. Unused cartridges will be returned to supply source.

VI. FLIGHT ENVELOPE EMBLEM: N/A

VII. SYSTEM SAFETY ANALYSIS:

The available information of JP-8 indicates that it has a higher flash point and lower volatility then JP-4; therefore, there is less chance of fire during fuel spillage. JP-8 has been used in F-4 aircraft with no major problems according to the flight test report from Edwards AFB, California. The only problem area that we know of is that in cold weather the engine may/maynot be able to start. This could result in engine over temperature/or hung start. Since the engine EGT and engine start time will be monitored closely, the engine over temperature can be prevented; therefore, we are of opinion that only the normal safety precautions are required. Similiar ground tests were conducted at Grand Forks AFB, North Dakota with no problems, therefore, no further system safety analysis is required.

VIII. PRE-TEST, FUNCTIONAL TESTS & INSPECTION REQUIREMENTS:

a. After engines have been modified with HEI and combustion chamber liner and have been reinstalled in the aircraft, the engines will be functionally checked for proper operation.

b. The pneumatic/electrical power ground carts will be functionally checked for proper operation.

c. Each cartridge, MXU/4A, will be inspected for any defects, and if a cartridge is found to be defective, the cartridge will be condemned and disposed in accordance with applicable T.O.

d. After each cartridge start, the cartridge chamber will be cleaned in accordance with applicable TO. 1F-4( )-2-8.

e. Prior to each ground start a prefligh inspection will be performed on the aircraft.

IX. TEST PROCEDURES:

a. The pneumatic and cartridges starts of these procedures will be accomplished per Table I. & Table II. Two starts perday per aircraft will be made with the cartridge being first start of the day followed by a pneumatic start in the afternoon.

b. Pneumatic Start:

(1) Deliver test aircraft to climatic chamber & secure.

(2) Service test aircraft with fuel if required.

(3) Cold soak test aircraft to test temperature condition.

(4) Pre-flight & prepared test aircraft for pneumatic start.

TABLE 1

TEST SCHEDULE

J79-15

NO OF RUNS	SPECIFIC GRAVITY SETTING	START MODE	TYPE OF FUEL	CLIMATIC CHAMBER TEMP OF	J79-15 Eng Test Condition RH	J79-15 Eng Test Condition LH	ENGINE/ACFT CONFIGURATION
1	0.78	CART/ PNEU	JP-4	40	HE1	STANDARD	C/B No 1 Pulled (Ignitor)
2				10	HE1	STANDARD	
3	0.82	CART/ PNEU	JP-8	40	HE1	STANDARD	C/B No 1 Pulled (Ignitor)
4				30			
5				20			
6				10			
7				0			
8				-10			
9				-20			
10	0.82	CART/ PNEU	JP-8	40	Modified Lined &	Modified Liner &	C/B No 2 Pulled Ignition
11				30	Standard	Standard	
12				20	Ignition	Ignition	
13				10	System	System	
14				0			
15				-10			
16				-20			
17	0.82	CART/ PNEU	JP-8	40	STANDARD	STANDARD	C/B No 1 Pulled RH Eng - 2 Ignitor has Stand Ignition LH Eng 2 Ignitor has standard Ignition
18				30			
19				20			
20				10			
21				0			
22				-10			
23				-20			
24	0.82	CART	JP-8	*?	MODIFIED	MODIFIED	C/B No 2 Pulled (Ignit
25				?	LINER	LINER	#1 Ignitor on RH & LH
26				?	WITH HE1	[redacted]	Engine will have HE1
27				?			Connected
28				?			
29				?			

* To be selected after above test has been completed and results analyzed.

TABLE II

TEST SCHEDULE

J79-17 ENGINE

No. Of RUNS	SPECIFIC GRAVITY SETTING	START-ING MODE	TYPE OF FUEL	CLIMATIC CHAMBER TEMP °F	J79-17 ENG ENG TEST CONDITION		ENGINE/ACFT CONFIGURATION
					RH	LH	
1	0.78	CART/ PNEU	JP-4	40°F	HE1	STANDARD	C/B No 1 Pulled (Ignitor)
2				10	HE1	STANDARD	
3	0.82	CART/ PNEU	JP-8	40	HE1	~~HE1~~ STANDARD	C/B No 1 Pulled Ignitor
4				30			
5				20			
6				10			
7				0			
8				-10			
9				-20			
10	0.82	CART/ PNEU	JP-8	40	MODIFIED LINER & STANDARD IGNITION SYSTEM	MODIFIED LINER & STANDARD IGNITION SYSTEM	C/B No 2 Pulled (Ignitor)
11				30			
12				20			
13				10			
14				0			
15				-10			
16				-20			
17	0.82	CART/ PNEU	JP-8	40	STANDARD	STANDARD	C/B No 1 Pulled RH Eng: #2 Ignitor has Standard Ignition. LH Eng: #2 Ignition has Standard Ignitor
18	0.78			30			
19	L.H.			20		0.78	
20				10			
21				0			
22				-10			
23				-20			
24	0.82	CART	JP-8	*?	MODIFIED LINER WITH HE1	MODIFIED LINER W~~ITH~~ ~~HE1~~	C/B No 2 pulled (Ignitor) #1 Ignitor on RH & LH Engine will have HE1 Connected.
25				?			
26				?			
27				?			
28				?			
29				?			

* To be selected after above test has been completed and results analyzed.

b. Prior to and during the ground start the following data is required and shall be recorded:

(1) Pneumatic ground cart pressure (psig-static head) and lowest pressure during start.

(2) Fuel Temp: The engine fuel manifold temperature will be recorded.

(3) Climatic chamber temp prior to each start.

(4) Cartridge serial number and lot number.

(5) Max engine EGT.

(6) Time to idle.

(7) Fuel flow (max and minimum).

(8) Cartridge burn out time.

(9) Type of starting mode, cartridge or pneumatic.

(10) Specific gravity setting on the main fuel control, 0.78 or 0.82.

(11) Engine ignition time.

(12) Operators remarks.

XI. TEST PROCEDURE CHANGE:

The ground starting test schedule (Table 1) can be changed at the descretion of the project engineer if it is determined during testing that additional tests are required, however, any additional tests to be performed will be coordinated with Eglin test group.

CAUTION NOTE

When engines operate under extreme cold condition, they will be operated IAW 1F-4C-2-8, Paragraph 2-41.

XII PHOTOGRAPHS:

A maximum of 15 photographs, 8 X 11 black and white, will be taken. The subjects to be photographed will be selected by the project engineer.

XIII Priority: The priority for evaluating JP-8 in Air Force Aircraft is FAD II, 2-7, which was established by HQ USAF.

(5) Pull the circuit breaker for the number 1 ignitor plugs for both engines.

(6) Start right engine. Starting procedure will be in accordance with TO 1F-4C( )-2-8 for pneumatic starts.

(7) Start left engine: Starting procedure will be in accordance with TO 1F-4( )-2-8. The right engine will remain at idle while starting the left engine.

(8) After both engines have obtained idle RMP, engines will be operated at Mil-Power for at least 30 seconds.

(9) Shut down engines and disconnect ground support equipment.

c. Cartridge Start:

(1) Deliver test aircraft to climatic chamber & secure.

(2) Service test aircraft with fuel if fuel level is below 3000 pounds.

(3) Cold soak test aircraft to test temperature condition.

(4) Pre-flight and prepare aircraft for cartridge start.

(5) Pull the circuit breakers for the number 1 ignitor plug for both engines.

(6) Start the right engine. Starting procedures will be in accordance with 1F-4C( )-2-8.

(7) Start the left engine. Starting procedure will be in accordance with 1F-4( )-2-8. The right hand engine will remain at idle when starting left hand engine.

(8) After both engines have been started and are at idle RPM, engines will be operated at Mil-Power for at least 30 seconds prior to shut down.

(9) Shut down engines.

(10) Remove spent cartridge starters using asbestos gloves to prevent burning of hand. After breech caps have cooled, the breech cap and chamber will be cleaned with non-metallic scouring pad, then cleaned with a cloth dampened in bicarbonate soda solution.

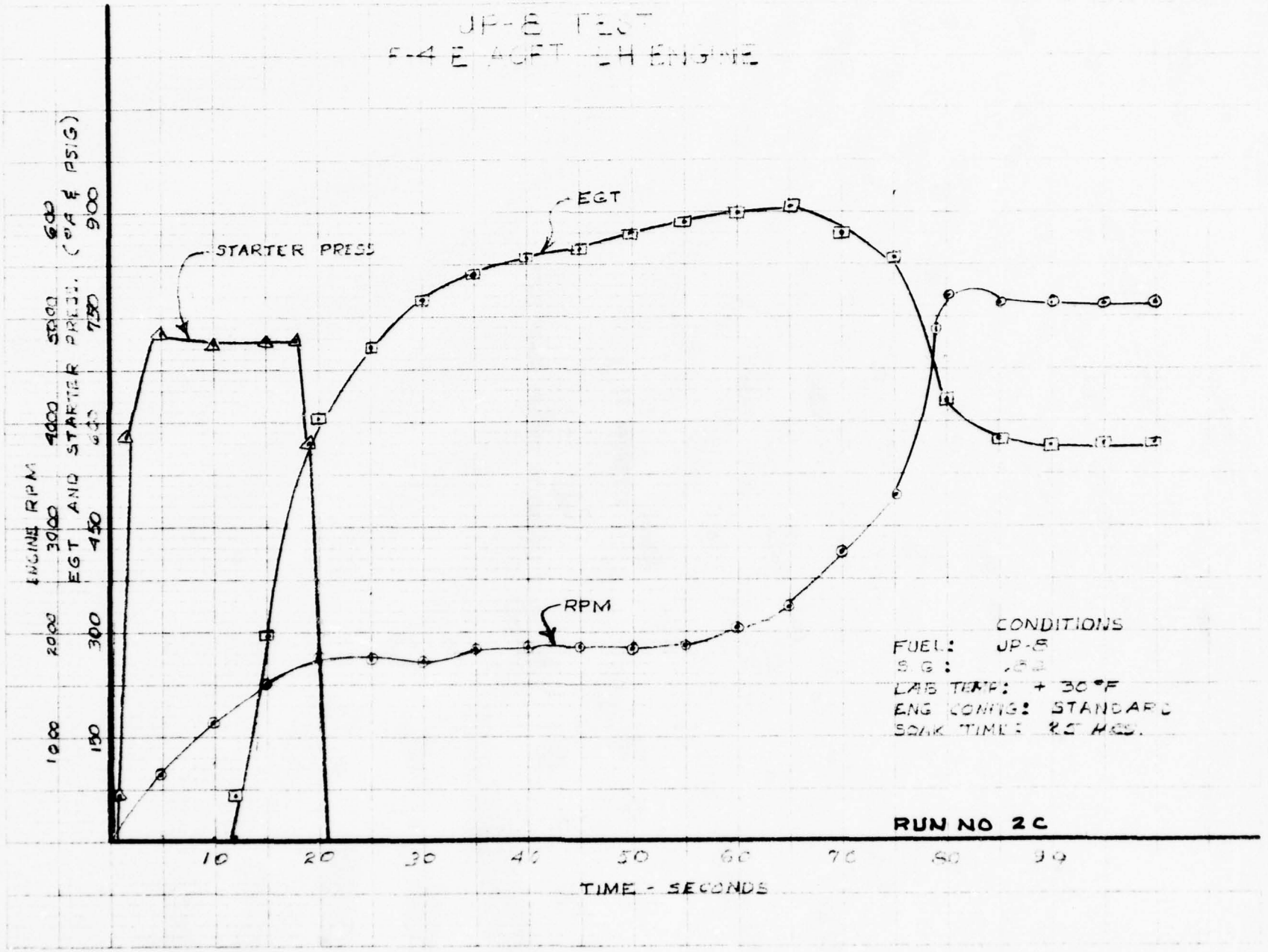
(11) Replace breech cap on starter.

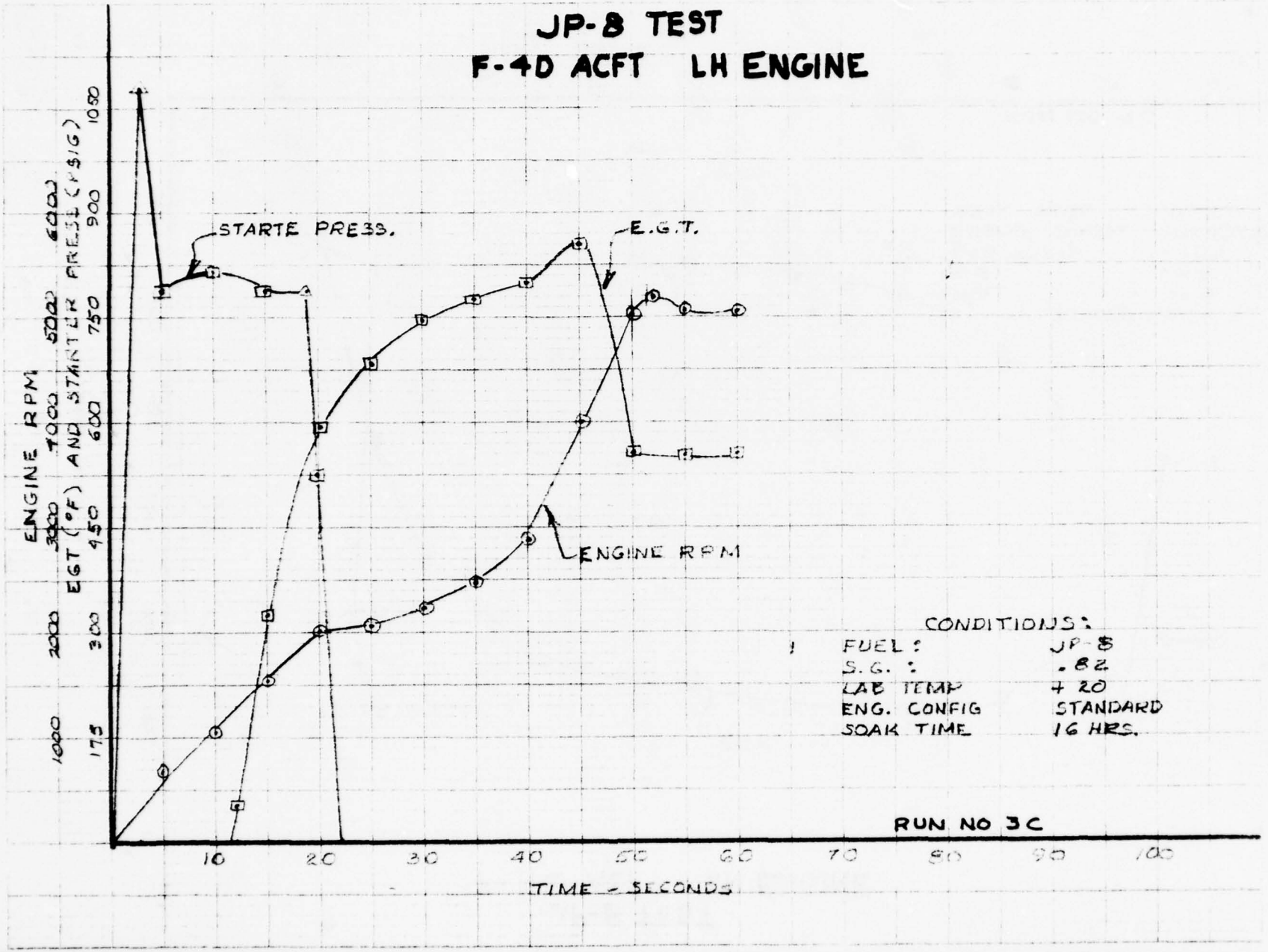
X. DATA REQUIREMENTS:

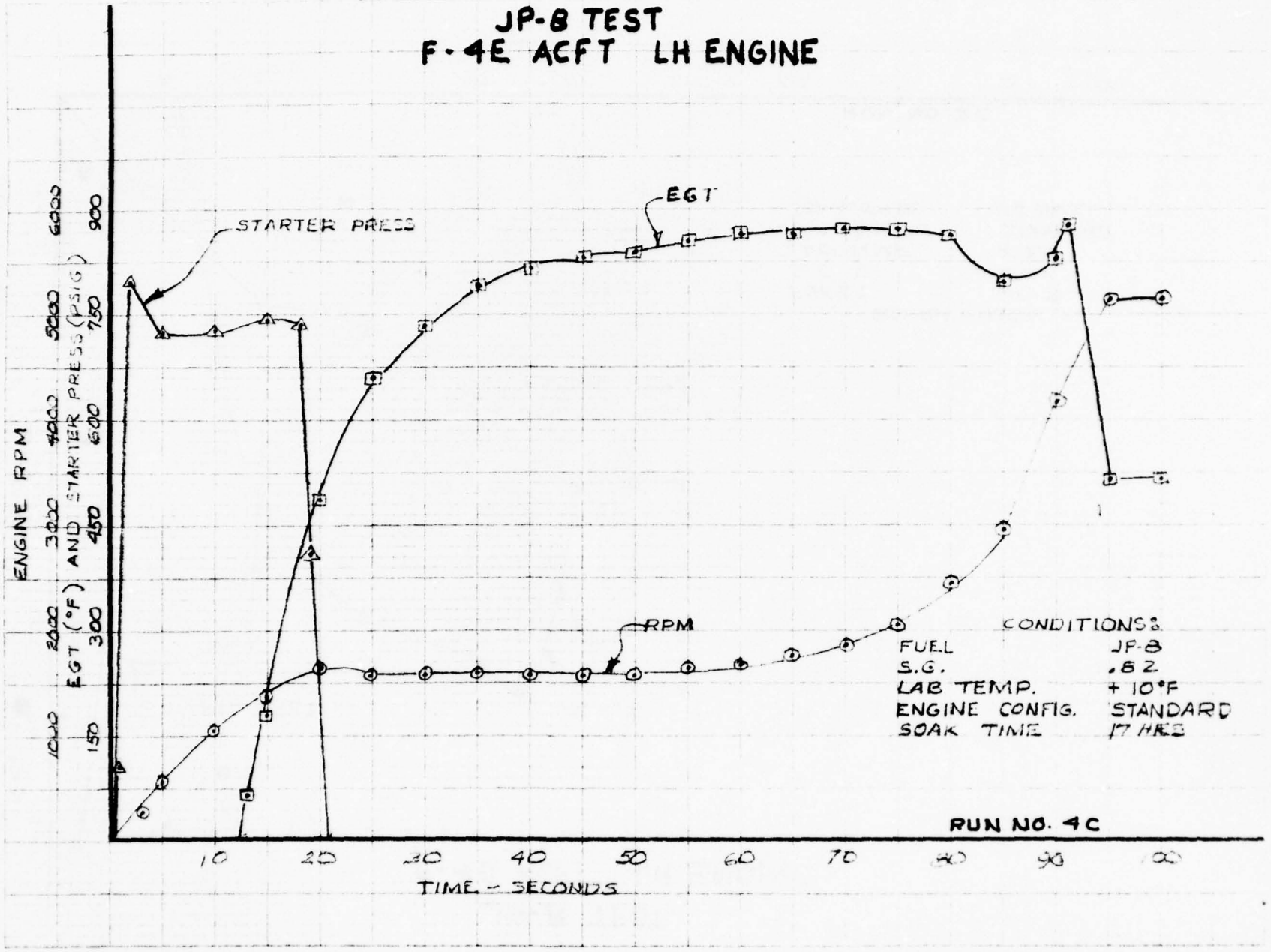
a. Statistical objective: To determine that the F-4 aircraft can be started in cold weather using JP-8 with specific gravity on the main fuel control set at 0.78 and 0.82.

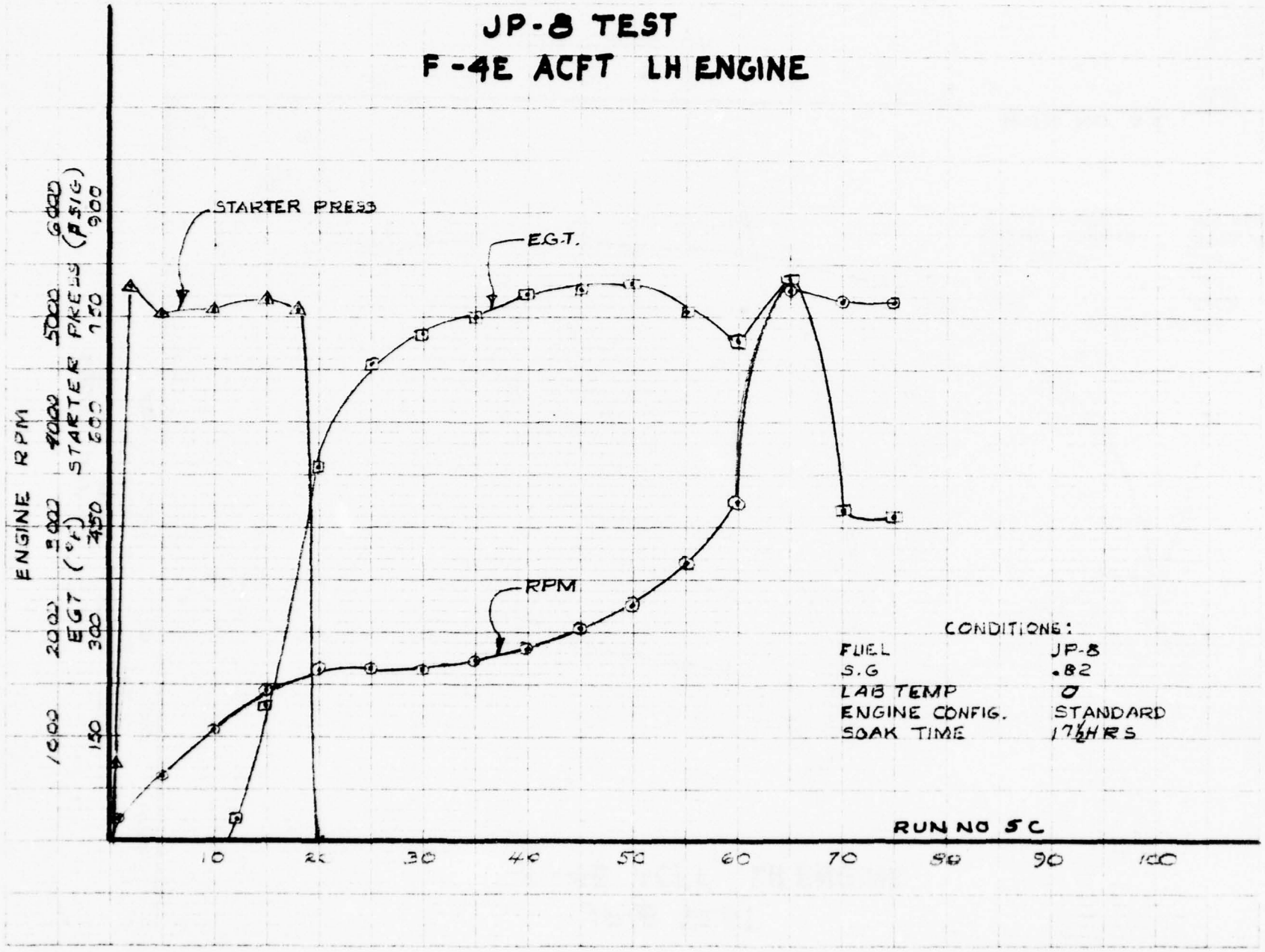
APPENDIX II

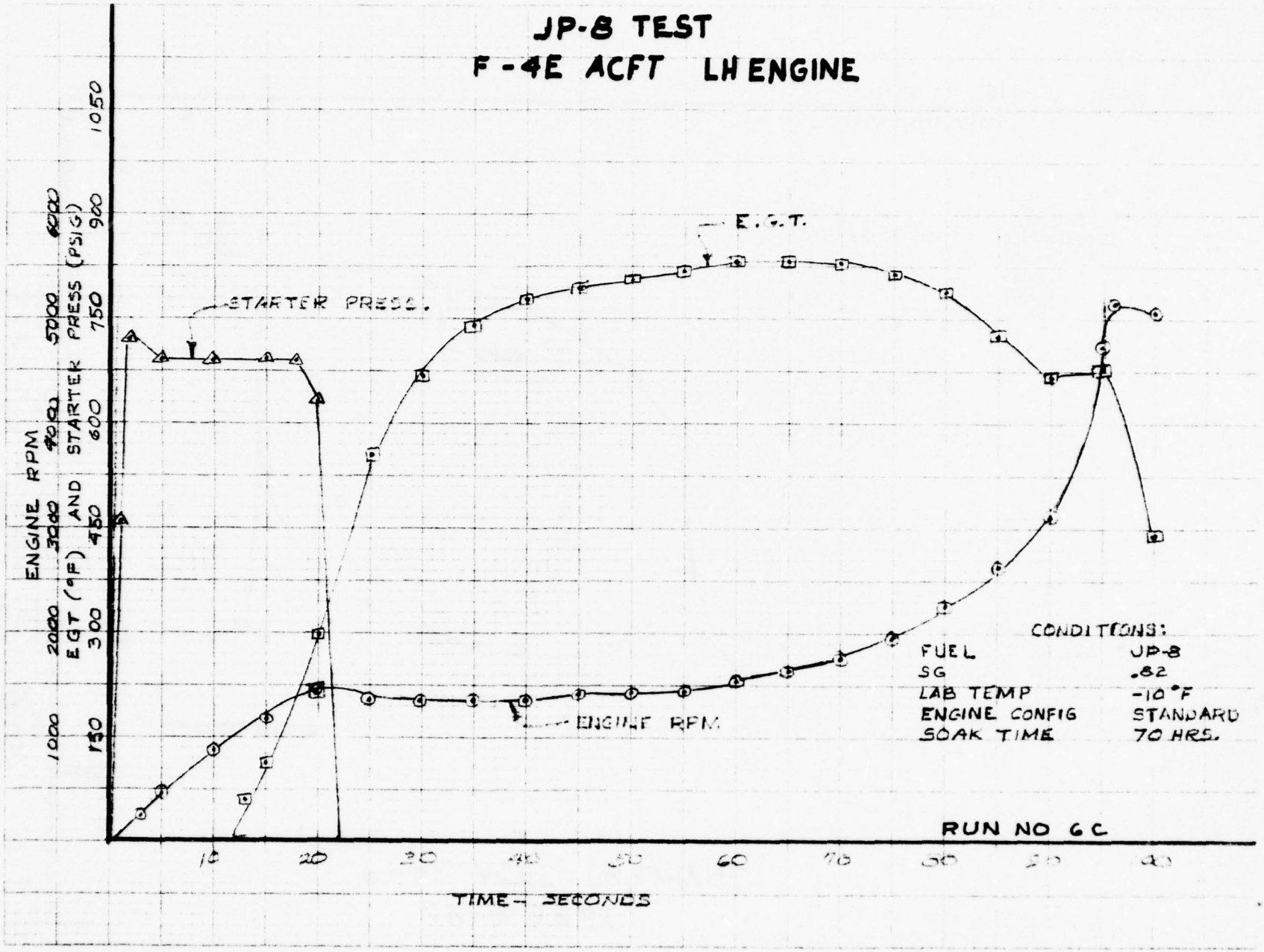
F-4E LH ENGINE GROUND START DATA

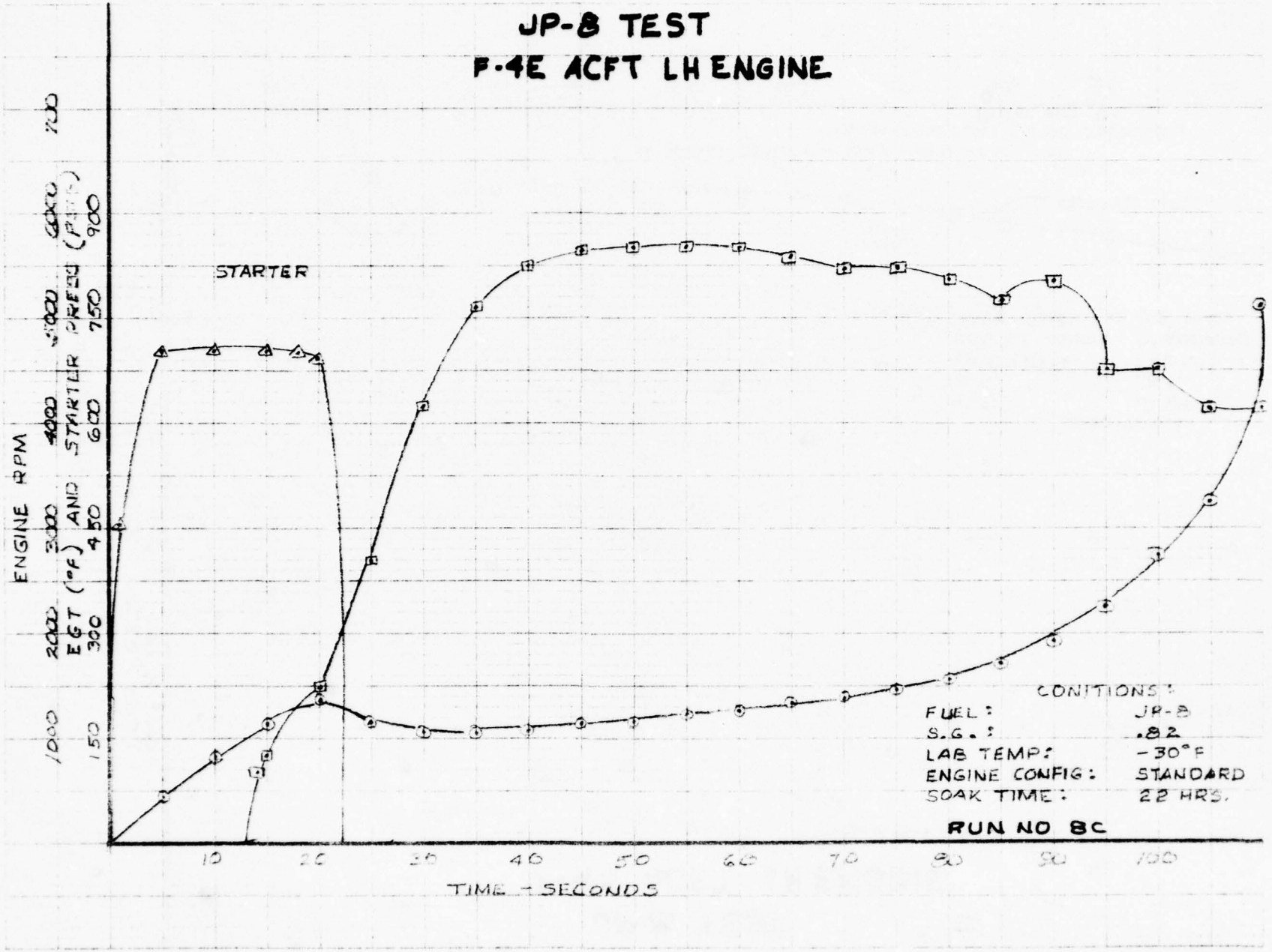

JP-8 TEST
F-4 E AFT LH ENGINE
ENGINE RPM
EGT AND STARTER PRESS. (PSIA & PSIG)
EGT
STARTER PRESS
RPM
CONDITIONS
FUEL: JP-8
S.G: .80
LAB TEMP: + 30°F
ENG CONFIG: STANDARD
SOAK TIME: 8 HRS.
RUN NO 2C
TIME - SECONDS

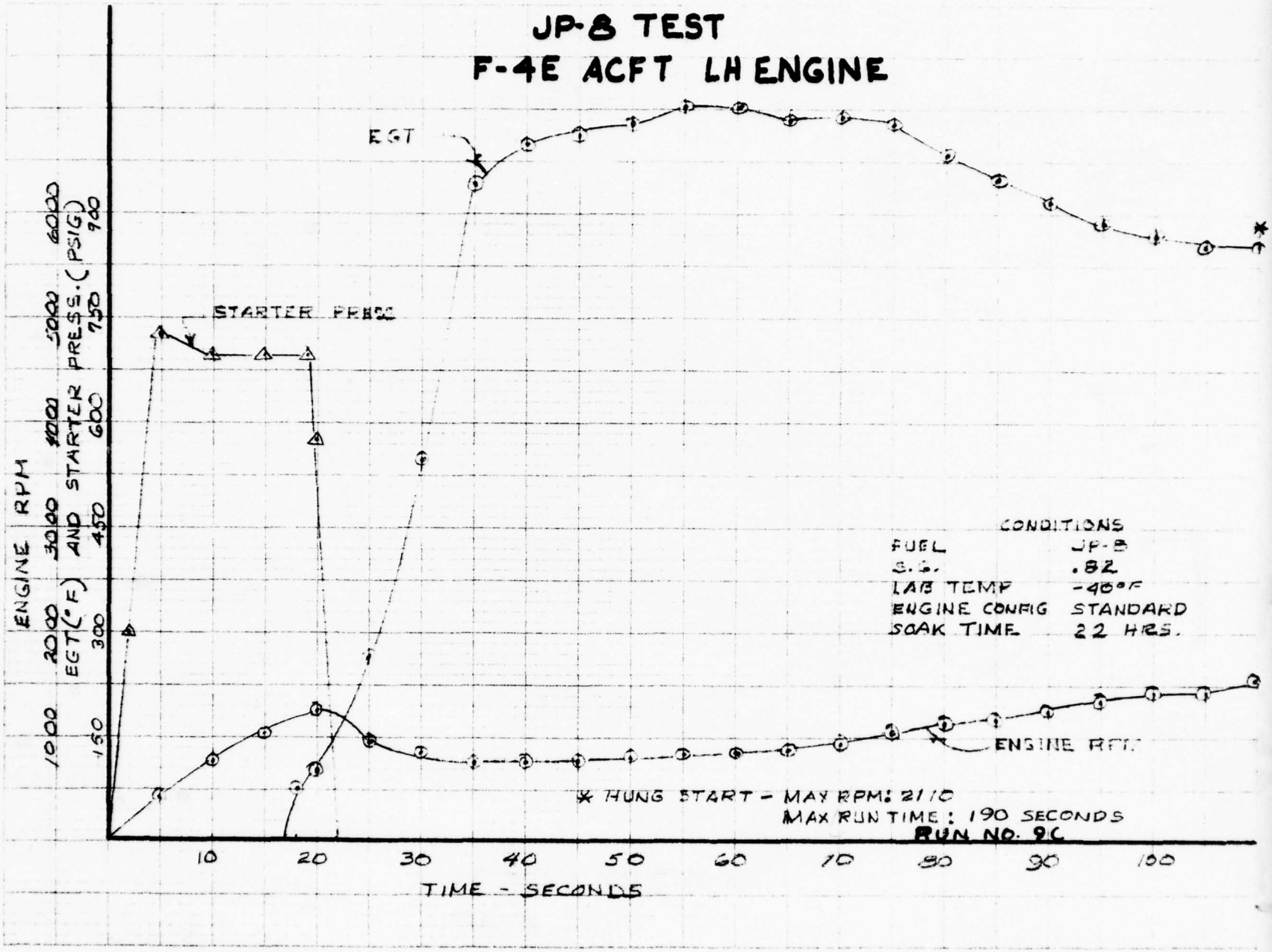

JP-8 TEST
F-4D ACFT LH ENGINE
ENGINE RPM
EGT (°F) AND STARTER PRESS (PSIG)
1000
2000
3000
4000
5000
6000
175
300
450
600
750
900
1050
STARTE PRESS.
E.G.T.
ENGINE RPM
CONDITIONS:
FUEL: JP-8
S.G.: .82
LAB TEMP + 20
ENG. CONFIG STANDARD
SOAK TIME 16 HRS.
RUN NO 3C
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS


JP-8 TEST
F-4E ACFT LH ENGINE
EGT
STARTER PRESS
RPM
ENGINE RPM
EGT (°F) AND STARTER PRESS (PSIG)
1000 2000 3000 4000 5000 6000
150 300 450 600 750 900
10 20 30 40 50 60 70 80 90 100
TIME - SECONDS
CONDITIONS:
FUEL JP-8
S.G. .82
LAB TEMP. + 10°F
ENGINE CONFIG. STANDARD
SOAK TIME 17 HRS
RUN NO. 4C

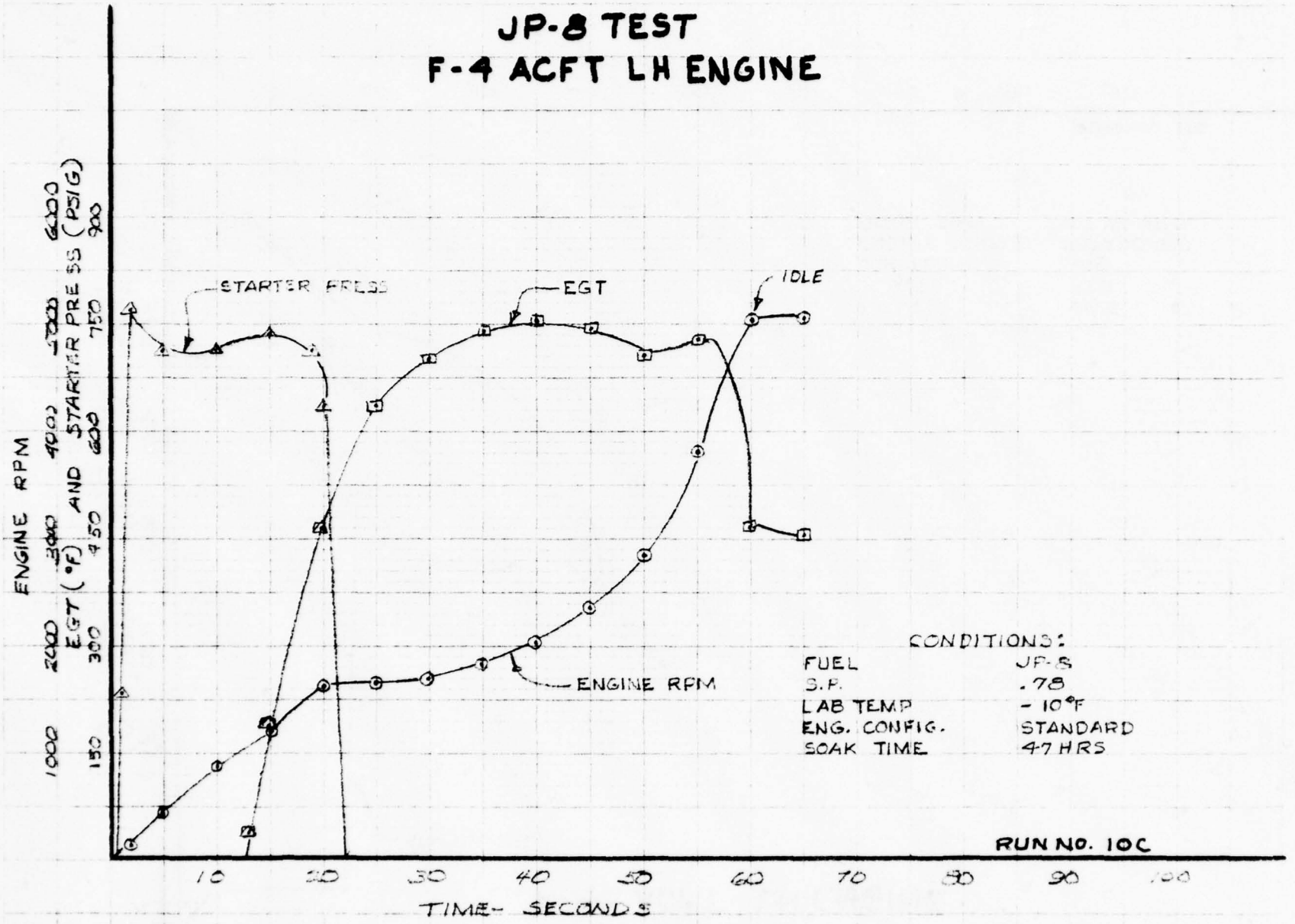

JP-8 TEST
F-4E ACFT LH ENGINE
STARTER PRESS
E.G.T.
RPM
ENGINE RPM
EGT (°F)
STARTER PRESS (PSIG)
CONDITIONS:
FUEL JP-8
S.G .82
LAB TEMP 0
ENGINE CONFIG. STANDARD
SOAK TIME 17½ HRS
RUN NO 5C
10
20
30
40
50
60
70
80
90
100


JP-8 TEST
F-4E ACFT LH ENGINE
E.G.T.
STARTER PRESS.
ENGINE RPM
EGT (°F) AND STARTER PRESS (PSIG)
1000
2000
3000
4000
5000
6000
150
300
450
600
750
900
1050
ENGINE RPM
CONDITIONS:
FUEL JP-8
SG .82
LAB TEMP -10 °F
ENGINE CONFIG STANDARD
SOAK TIME 70 HRS.
RUN NO 6C
10
20
30
40
50
60
70
80
90
100
110
TIME - SECONDS


JP-8 TEST
F-4E ACFT LH ENGINE
STARTER
ENGINE RPM
EGT (°F) AND STARTER PRESS (PSIG)
1000
2000
3000
4000
5000
6000
7000
150
300
450
600
750
900
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS
CONITIONS:
FUEL: JP-8
S.G.: .82
LAB TEMP: -30°F
ENGINE CONFIG: STANDARD
SOAK TIME: 22 HRS.
RUN NO 8C

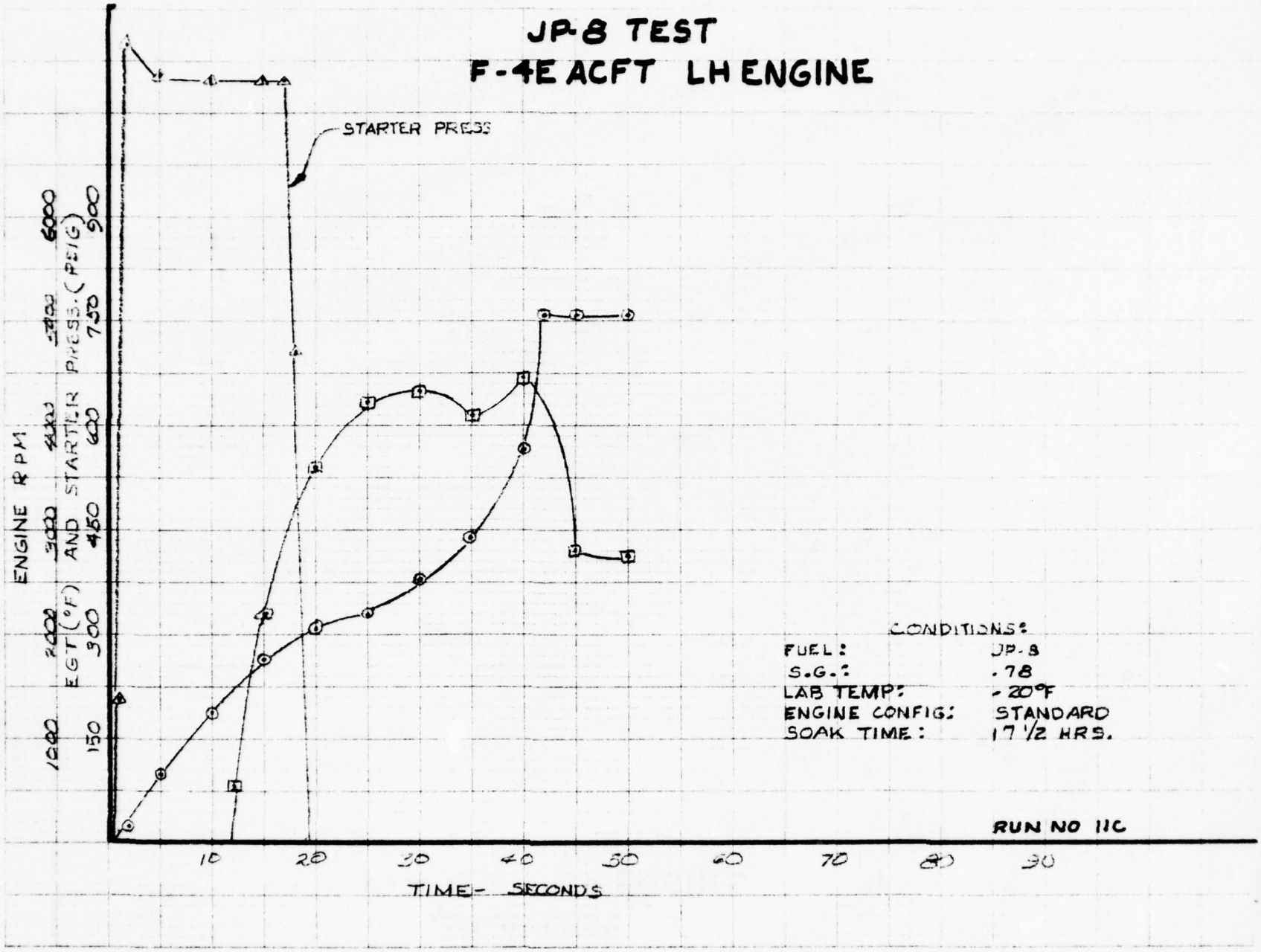

JP-8 TEST
F-4E ACFT LH ENGINE
EGT
STARTER PRESS
ENGINE RPM
EGT(°F) AND STARTER PRESS.(PSIG)
10000 20000 30000 40000 50000 60000
150 300 450 600 750 900
CONDITIONS
FUEL JP-8
S.G. .82
LAB TEMP -40°F
ENGINE CONFIG STANDARD
SOAK TIME 22 HRS.
ENGINE RPM
* HUNG START - MAX RPM: 2110
MAX RUN TIME: 190 SECONDS
RUN NO. 9C
10 20 30 40 50 60 70 80 90 100
TIME - SECONDS

JP-8 TEST
F-4 ACFT LH ENGINE



38

JP-8 TEST
F-4E ACFT LH ENGINE

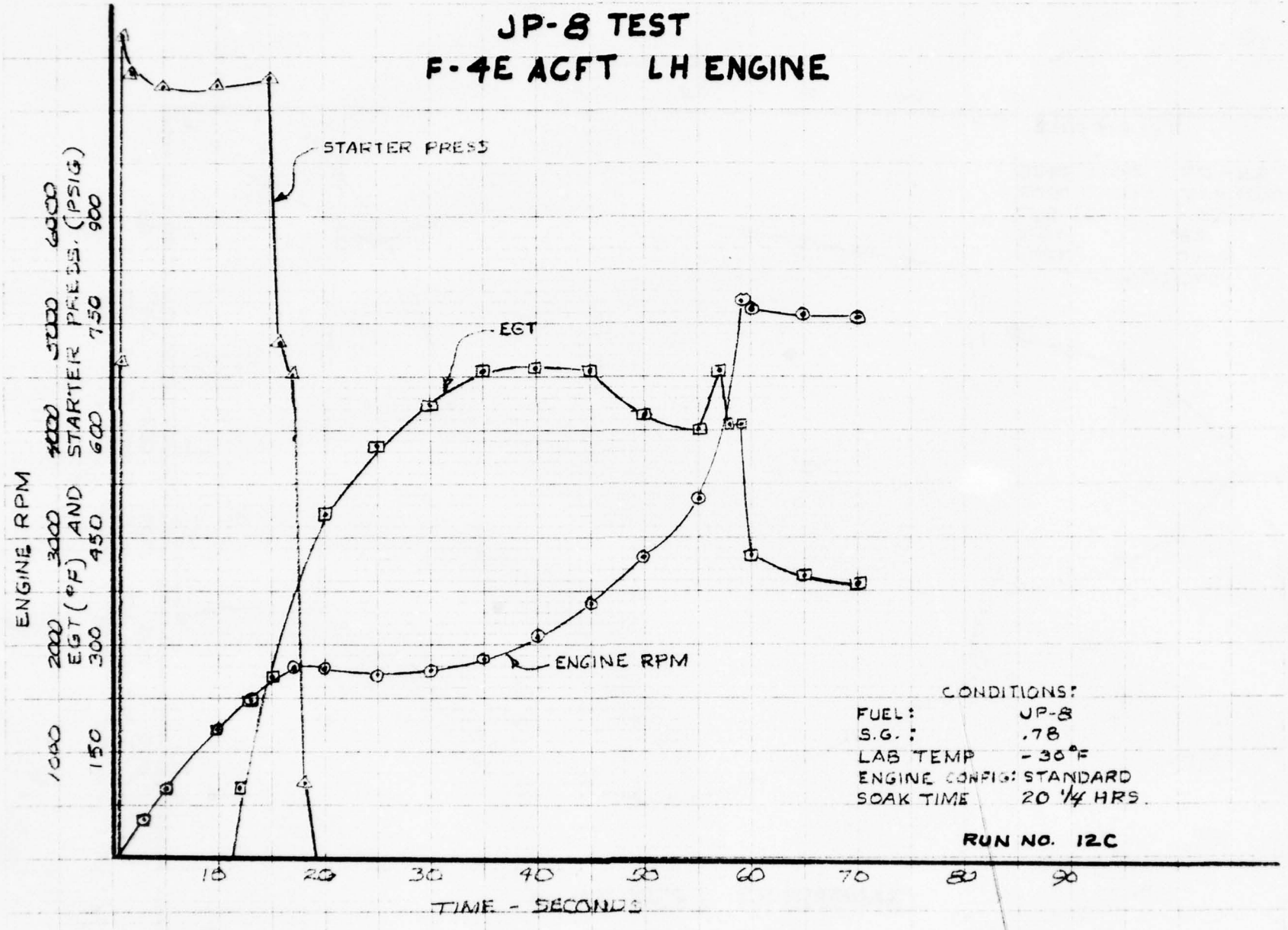


CONDITIONS:

FUEL:	JP-8
S.G.:	.78
LAB TEMP:	-20°F
ENGINE CONFIG:	STANDARD
SOAK TIME:	17 1/2 HRS.

RUN NO 11C

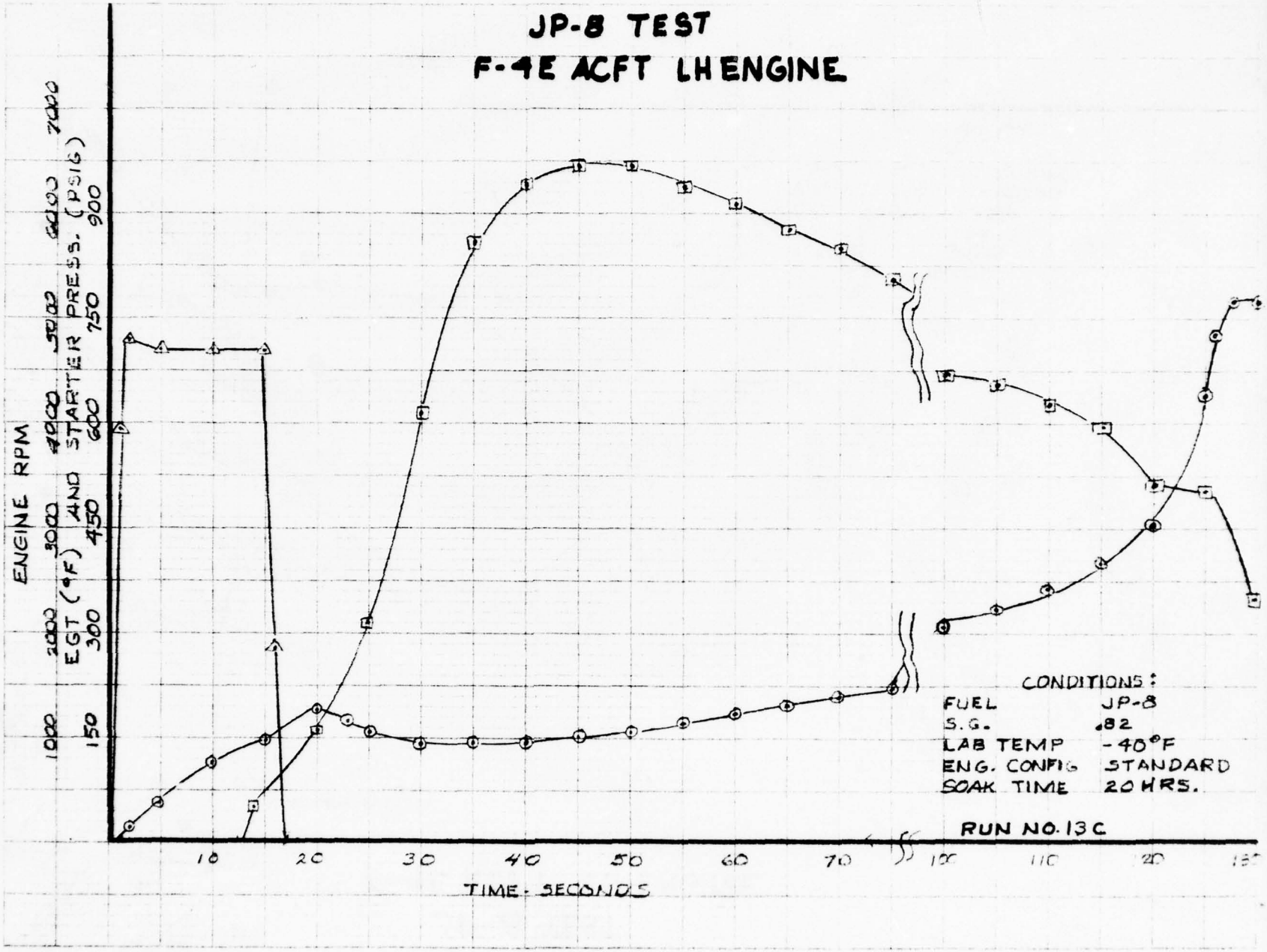
JP-8 TEST
F-4E ACFT LH ENGINE

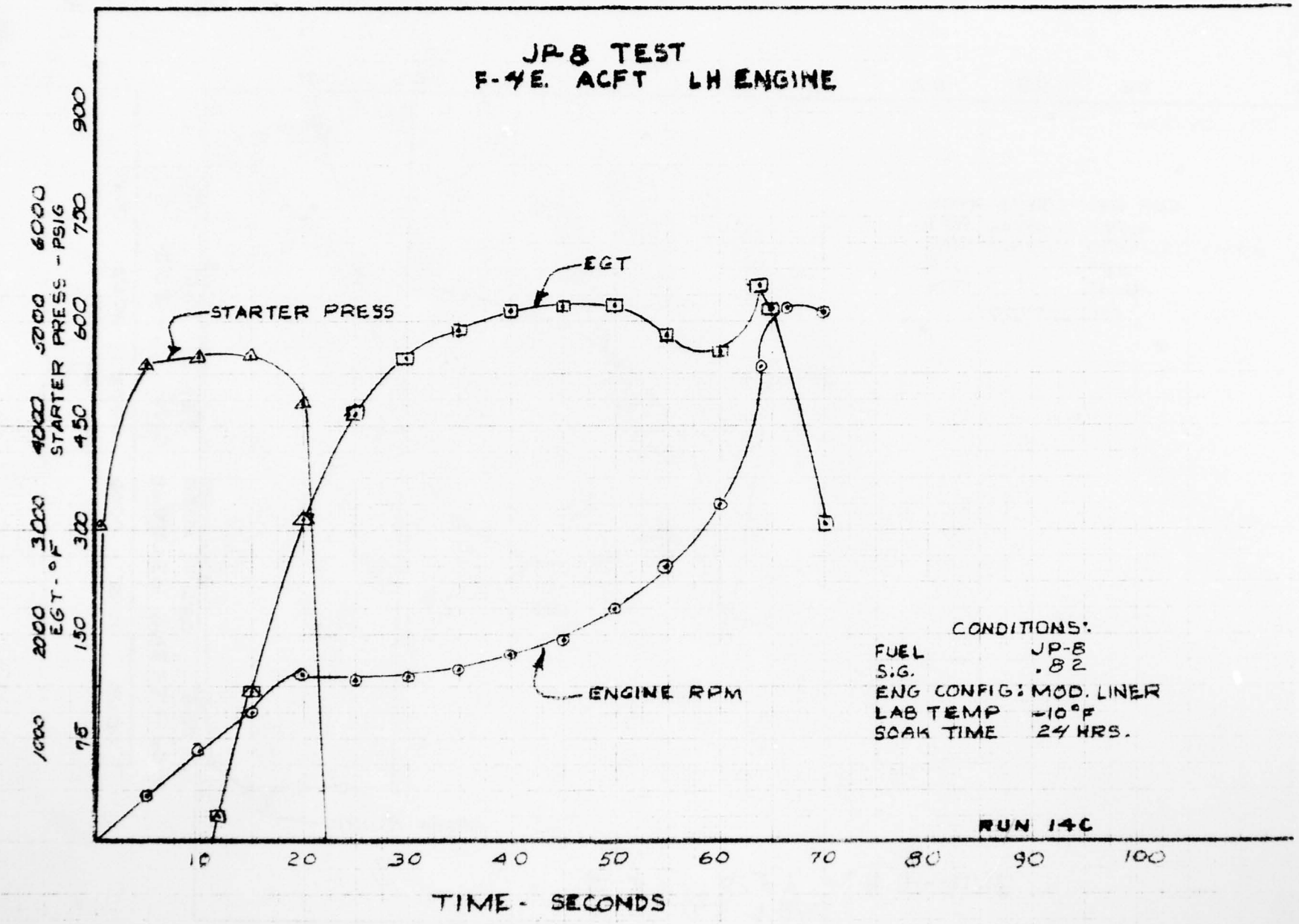


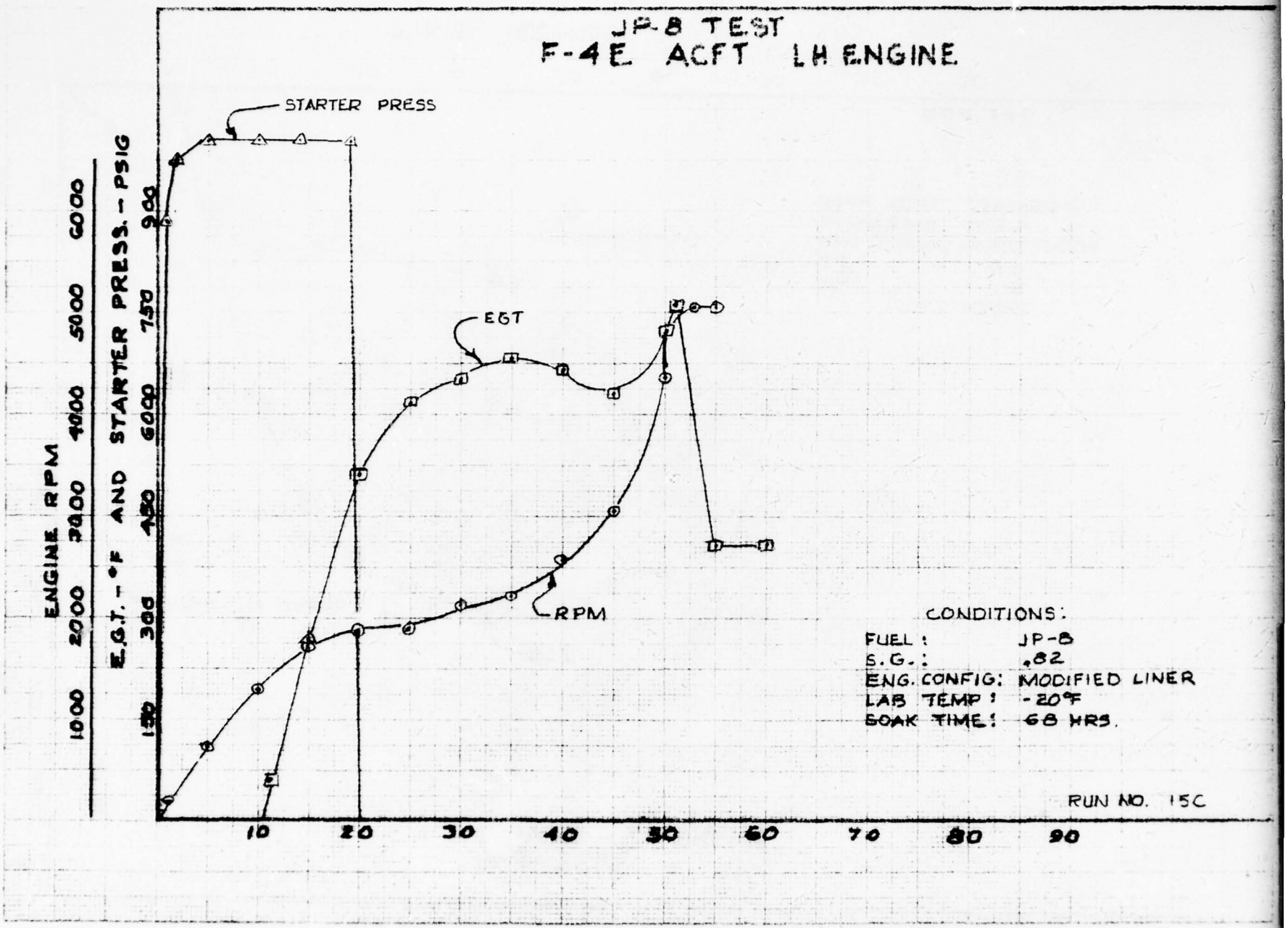
CONDITIONS:

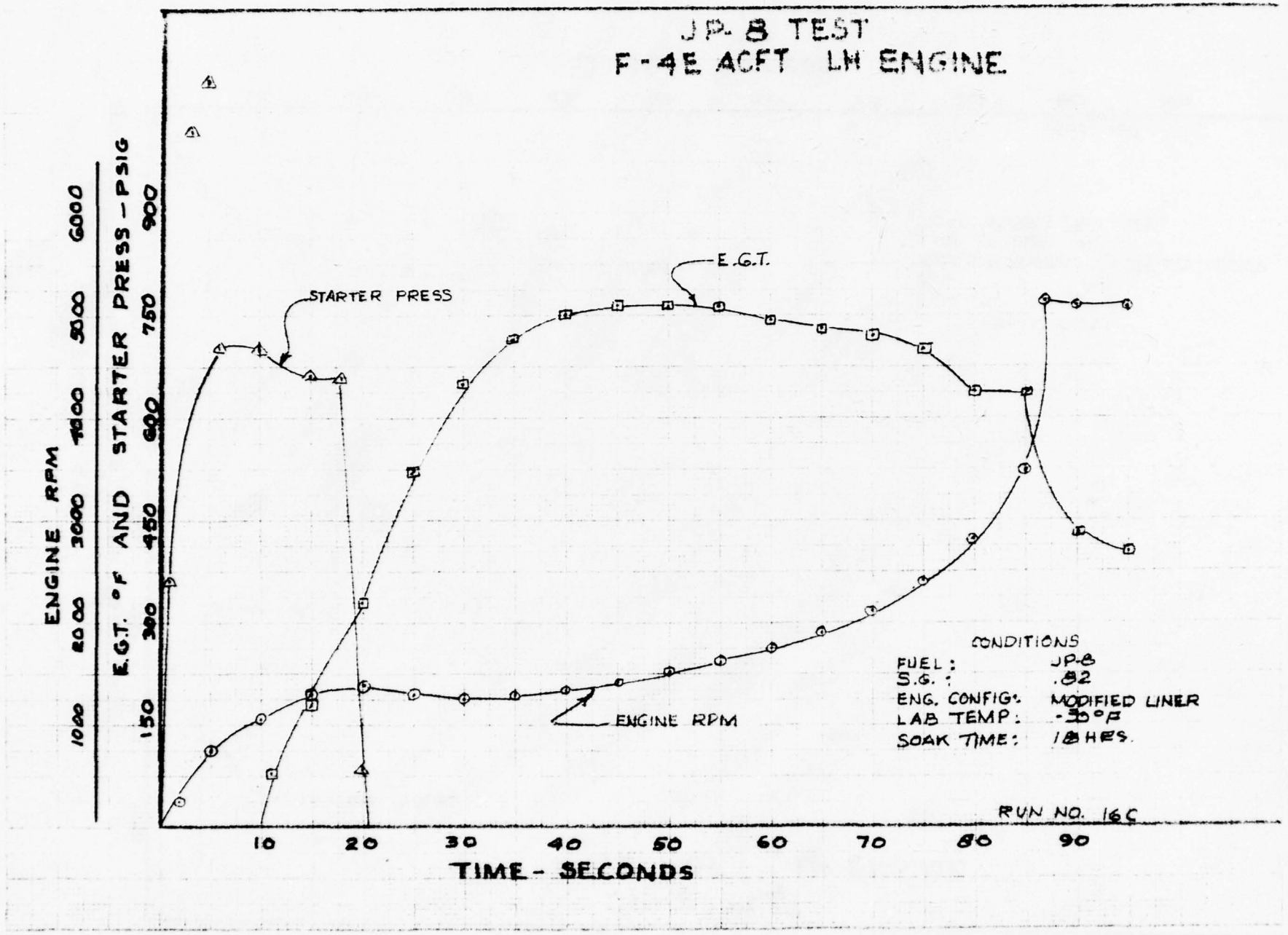
FUEL:	JP-8
S.G.:	.78
LAB TEMP	-30°F
ENGINE CONFIG:	STANDARD
SOAK TIME	20 1/4 HRS.

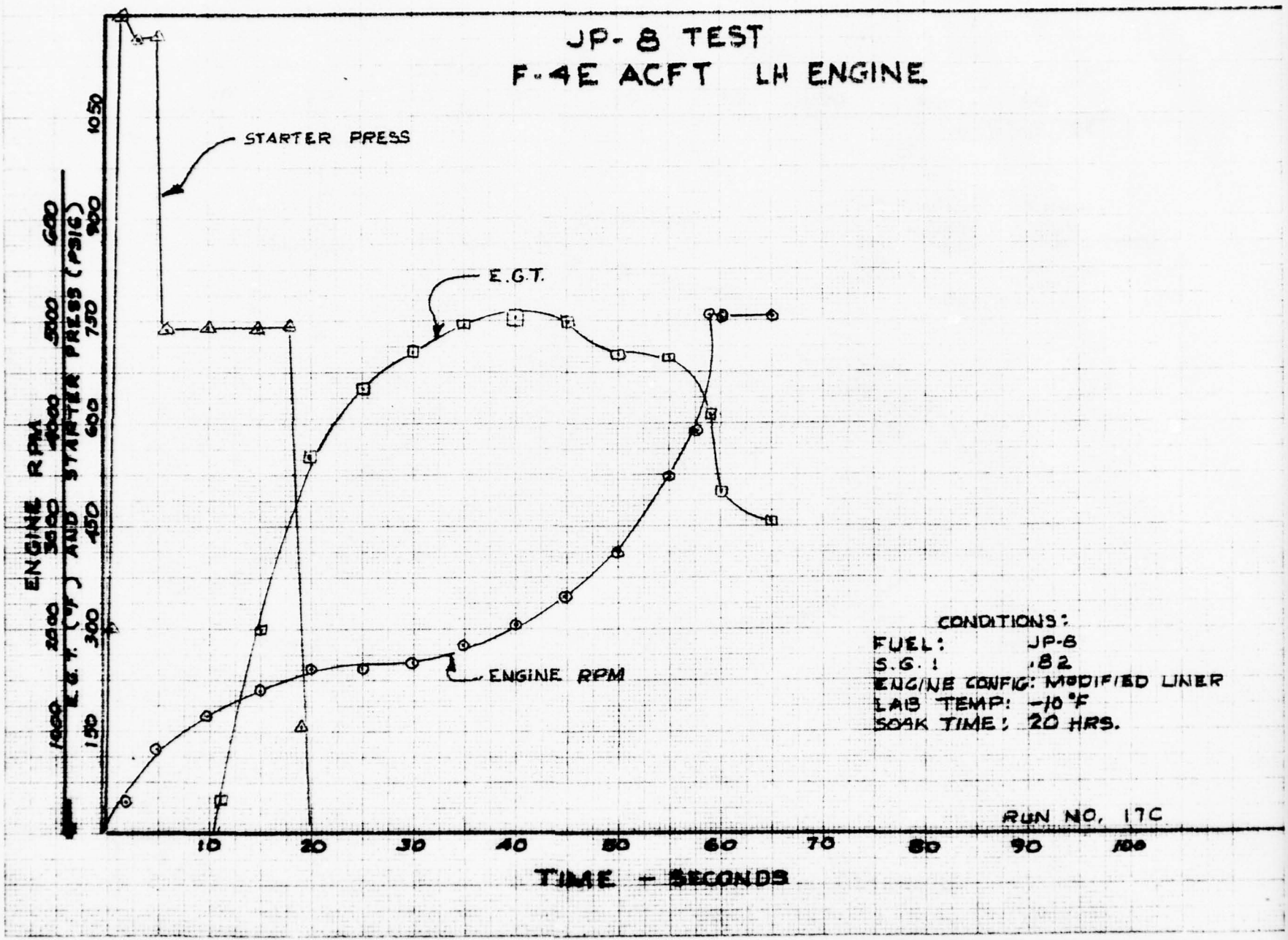
RUN NO. 12C

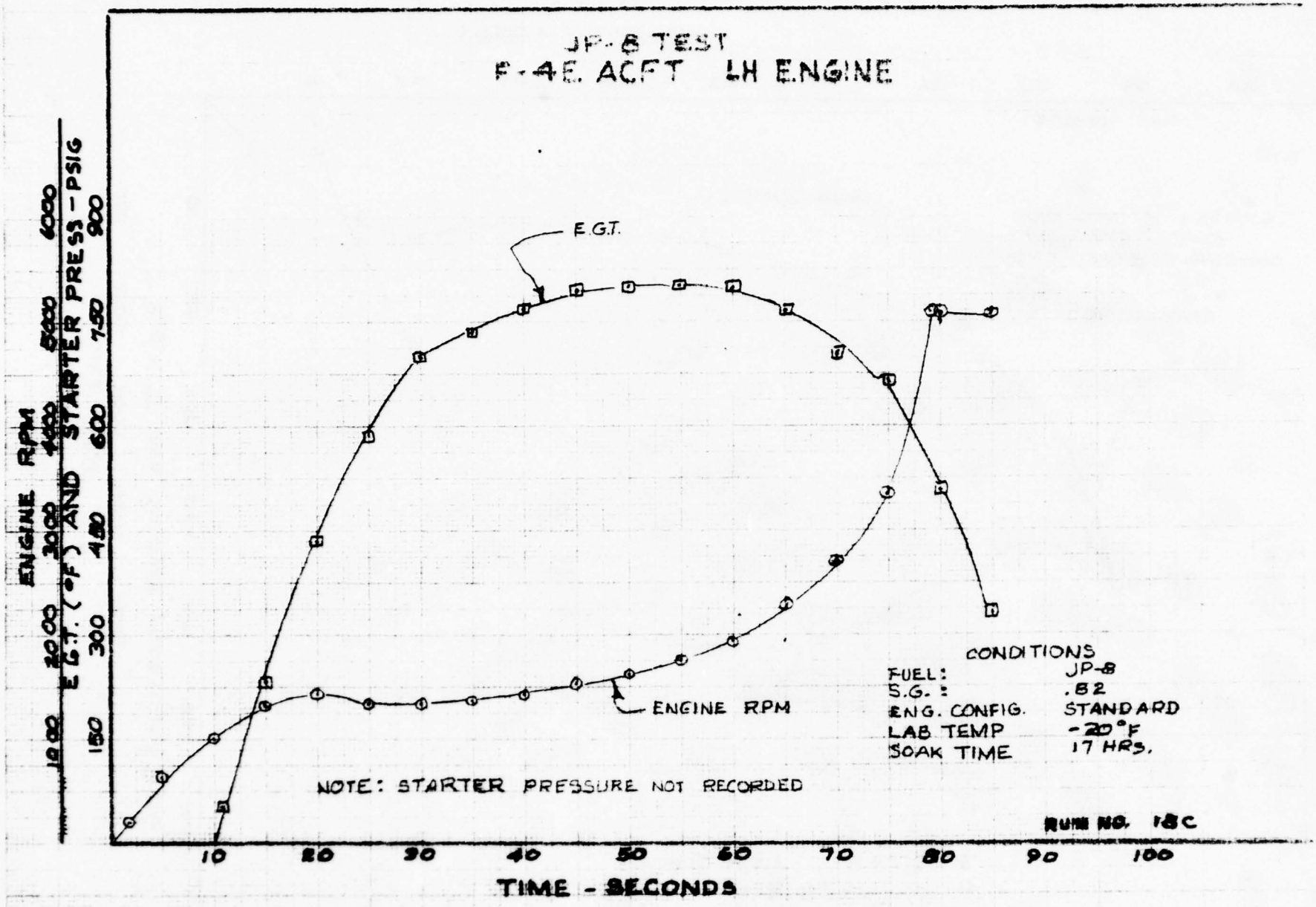

JP-8 TEST
F-4E ACFT LH ENGINE
ENGINE RPM
1000
2000
3000
4000
5000
6000
7000
EGT (°F) AND STARTER PRESS. (PSIG)
150
300
450
600
750
900
10
20
30
40
50
60
70
TIME - SECONDS
CONDITIONS:
FUEL JP-8
S.G. .82
LAB TEMP -40°F
ENG. CONFIG STANDARD
SOAK TIME 20 HRS.
RUN NO. 13C

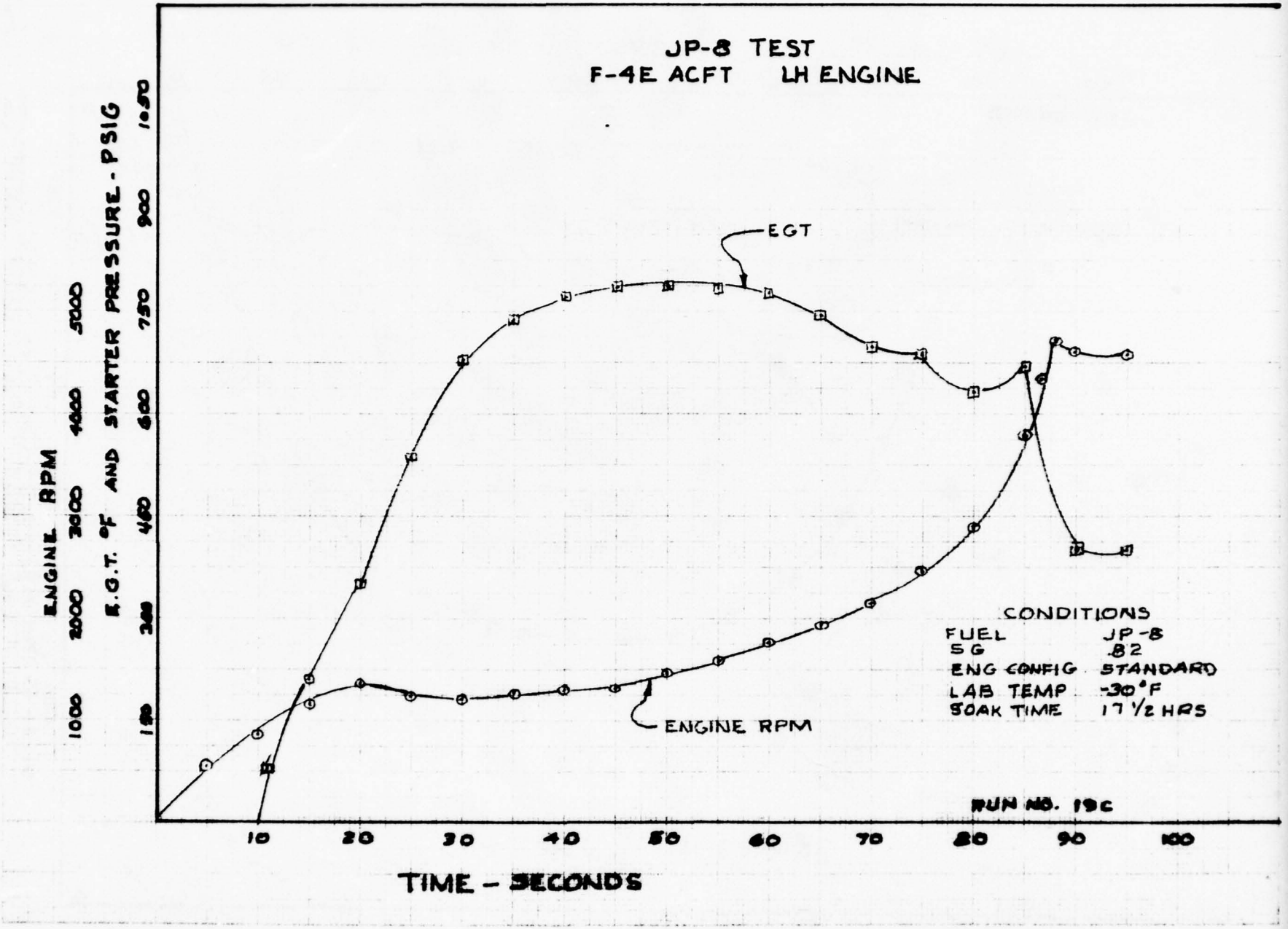

JP-8 TEST
F-4E. ACFT LH ENGINE
EGT
STARTER PRESS
ENGINE RPM
CONDITIONS:
FUEL JP-8
S.G. .82
ENG CONFIG: MOD. LINER
LAB TEMP -10°F
SOAK TIME 24 HRS.
RUN 14C
EGT - °F
STARTER PRESS - PSIG
TIME - SECONDS

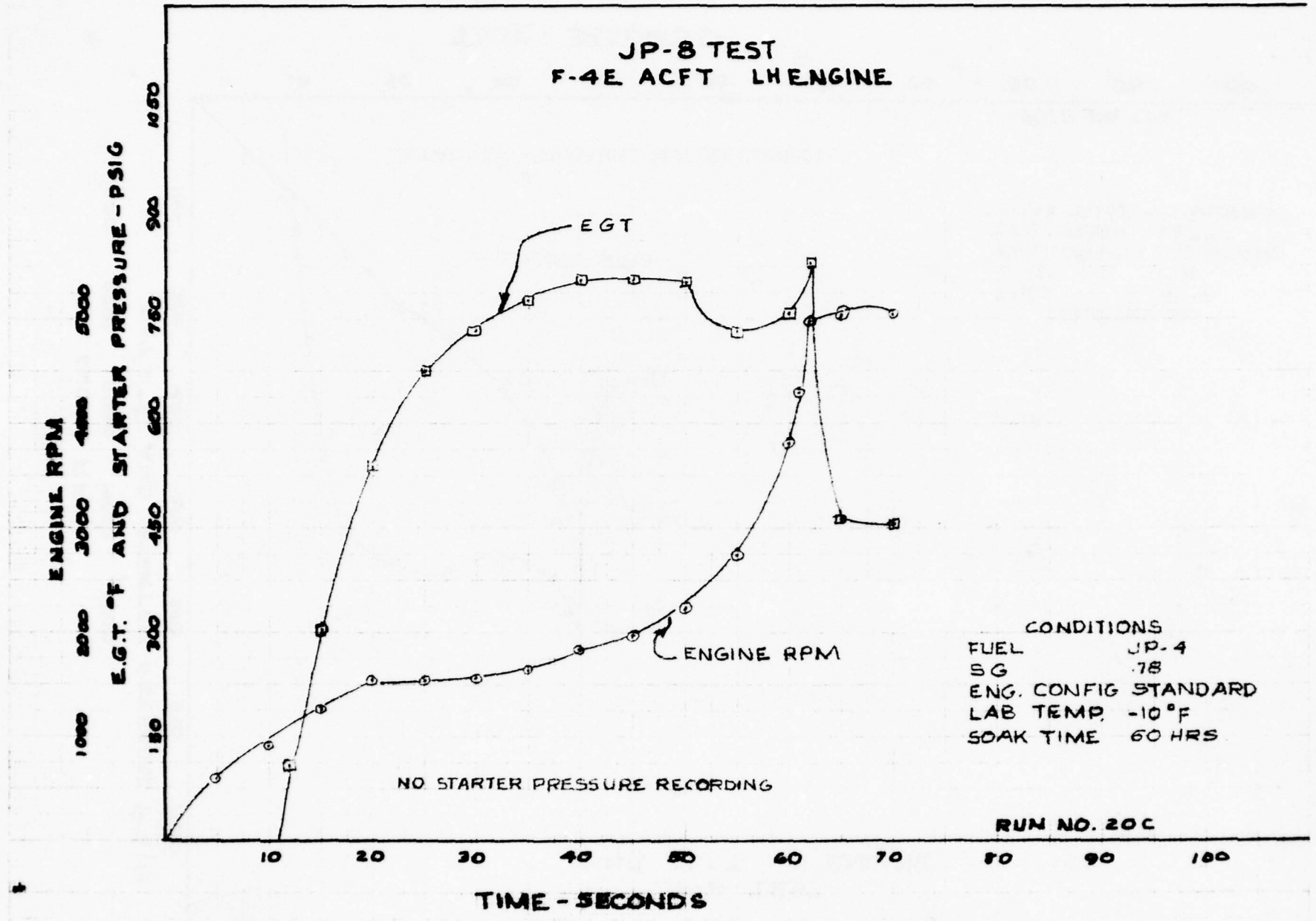

JP-8 TEST
F-4E ACFT LH ENGINE
STARTER PRESS
EGT
RPM
E.G.T. - °F AND STARTER PRESS. - PSIG
ENGINE RPM
1000
2000
3000
4000
5000
6000
750
600
450
300
150
10
20
30
40
50
60
70
80
90
CONDITIONS:
FUEL: JP-8
S.G.: .82
ENG. CONFIG: MODIFIED LINER
LAB TEMP: -20°F
SOAK TIME: 68 HRS.
RUN NO. 15C

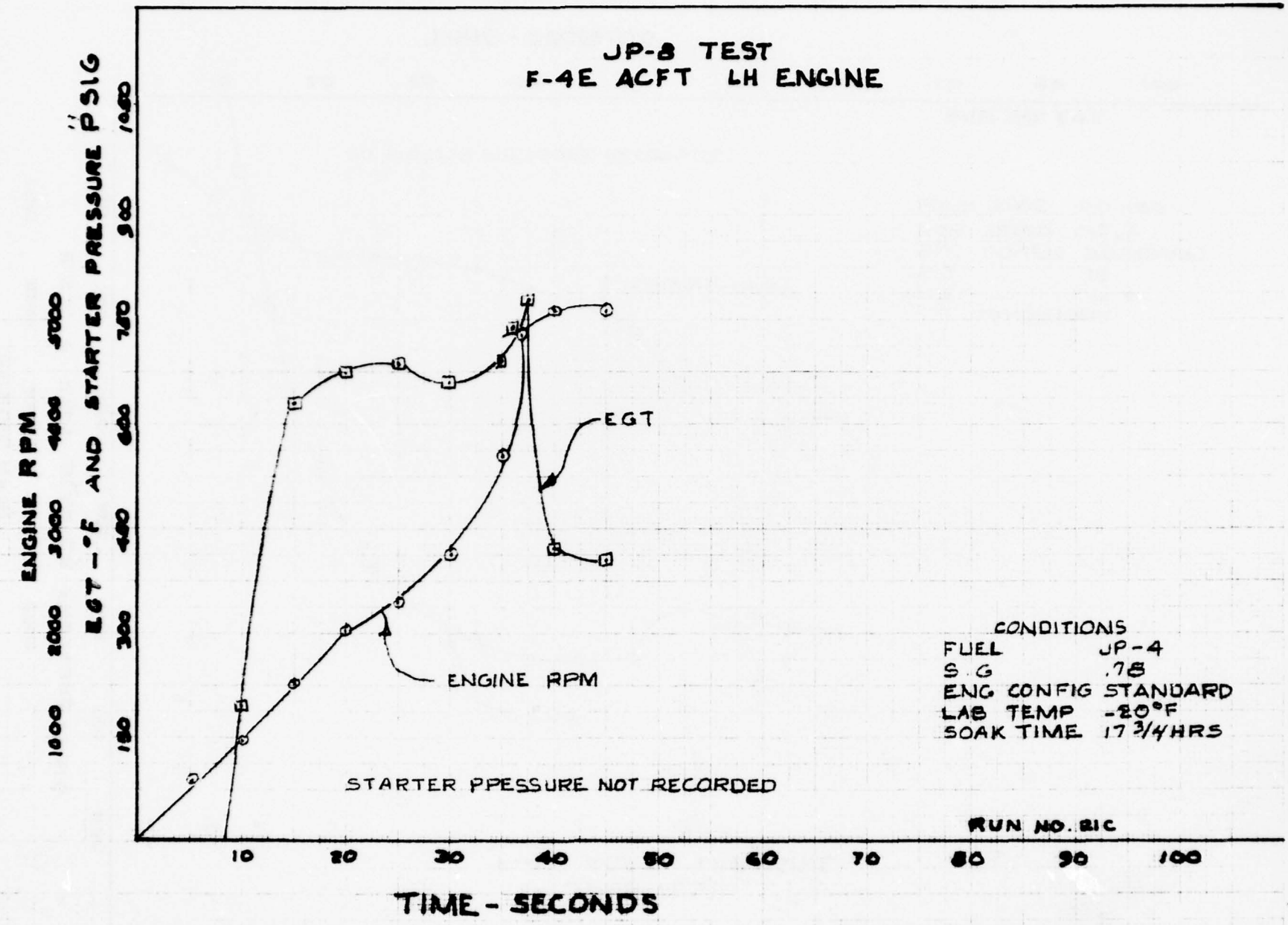

JP-8 TEST
F-4E ACFT LH ENGINE
E.G.T. °F AND STARTER PRESS - PSIG
ENGINE RPM
1000
2000
3000
4000
5000
6000
150
300
450
600
750
900
STARTER PRESS
E.G.T.
ENGINE RPM
CONDITIONS
FUEL: JP-8
S.G.: .82
ENG. CONFIG: MODIFIED LINER
LAB TEMP: -30°F
SOAK TIME: 18 HRS.
RUN NO. 16C
10
20
30
40
50
60
70
80
90
TIME - SECONDS

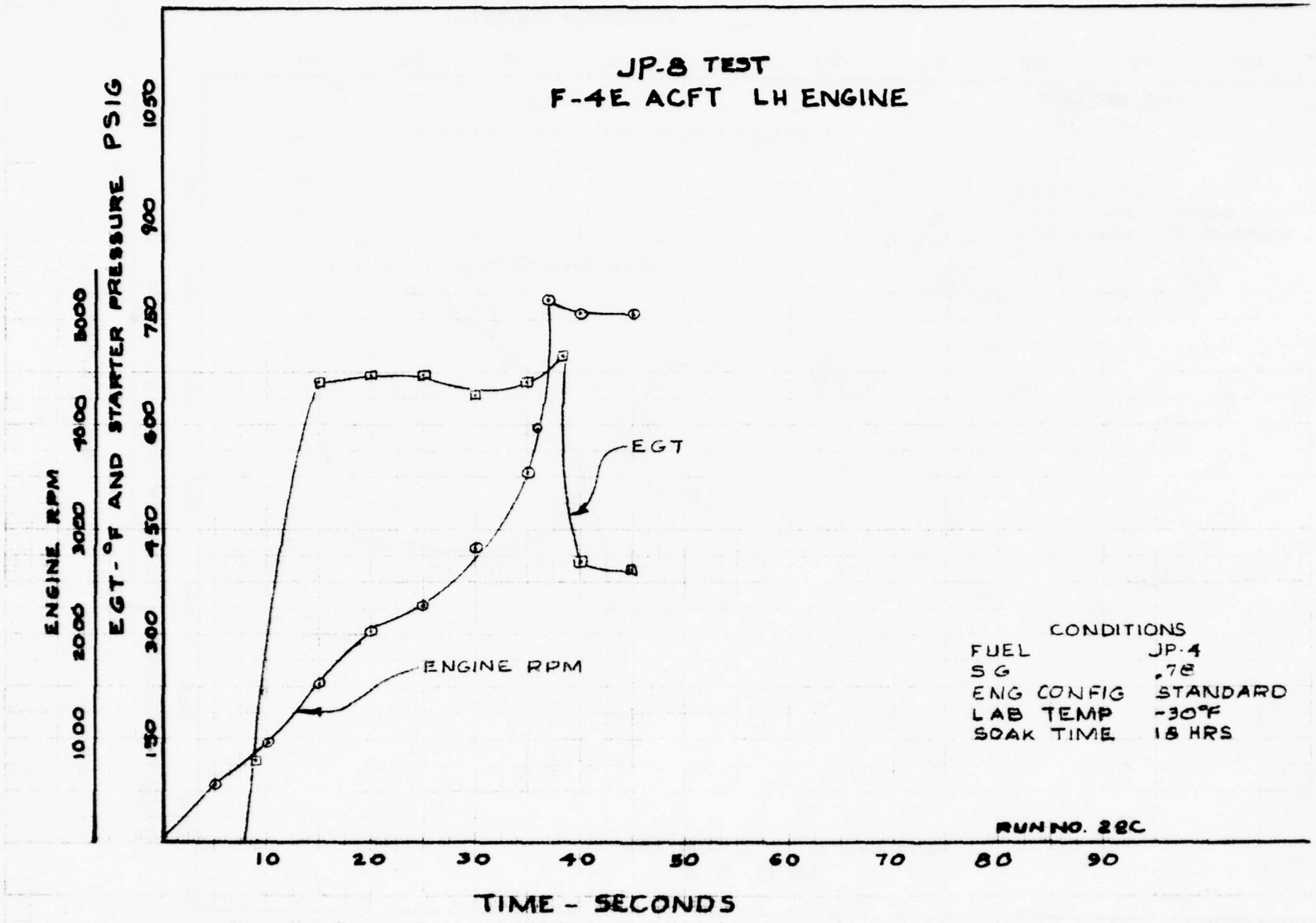

JP-8 TEST
F-4E ACFT LH ENGINE
STARTER PRESS
E.G.T.
ENGINE RPM
E.G.T. (°F) AND ENGINE RPM AND STARTER PRESS (PSIG)
1050
900
750
600
450
300
150
600
500
400
300
200
100
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS
CONDITIONS:
FUEL: JP-8
S.G.: .82
ENGINE CONFIG: MODIFIED LINER
LAB TEMP: -10 °F
SOAK TIME: 20 HRS.
RUN NO. 17C

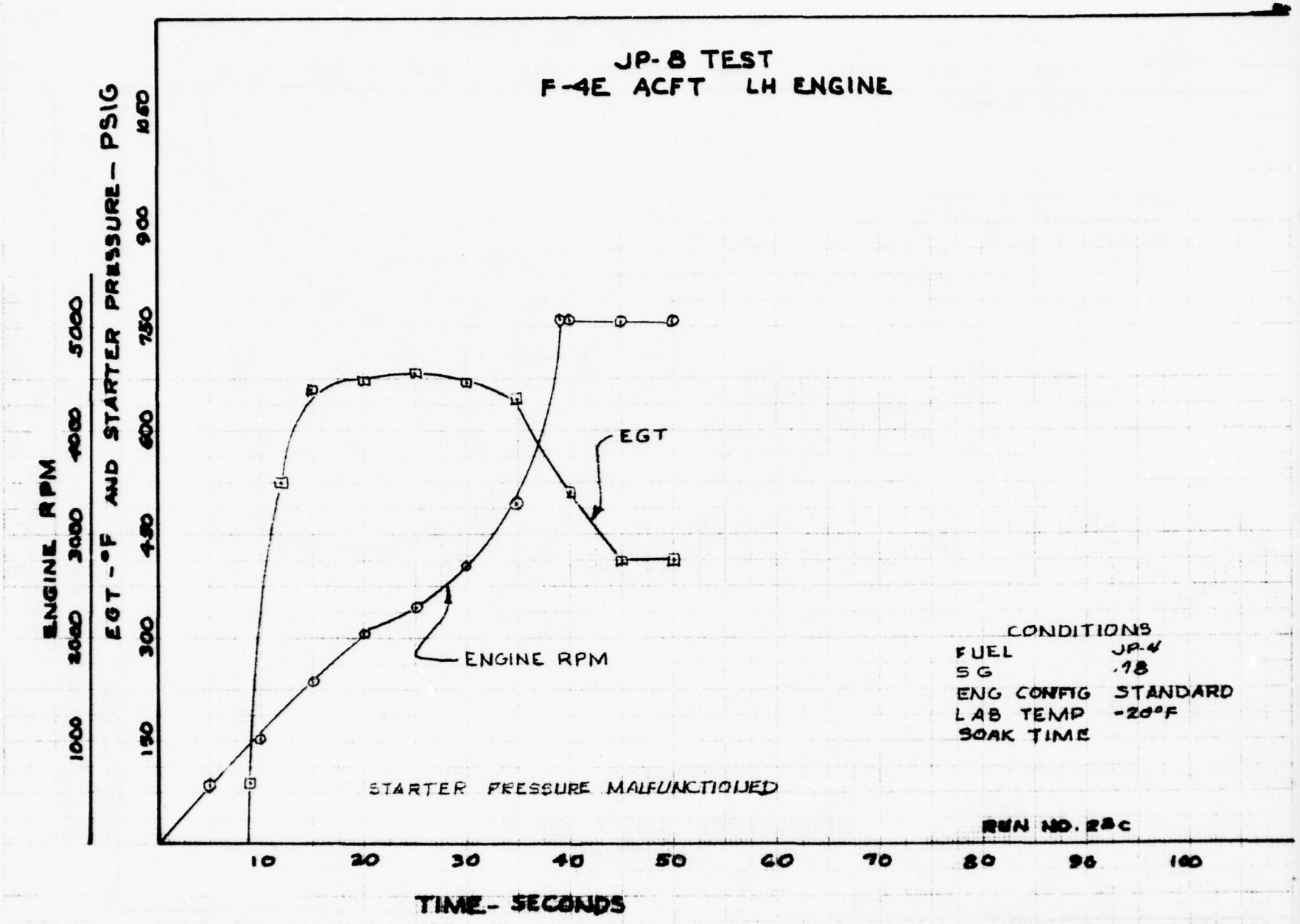

JP-8 TEST
F-4E ACFT LH ENGINE
E.G.T.
ENGINE RPM
NOTE: STARTER PRESSURE NOT RECORDED
CONDITIONS
FUEL: JP-8
S.G.: .82
ENG. CONFIG. STANDARD
LAB TEMP -20°F
SOAK TIME 17 HRS.
RUN NO. 18C
E.G.T. (°F) AND STARTER PRESS - PSIG
ENGINE RPM
1000 2000 3000 4000 5000 6000
150 300 450 600 750 900
10 20 30 40 50 60 70 80 90 100
TIME - SECONDS

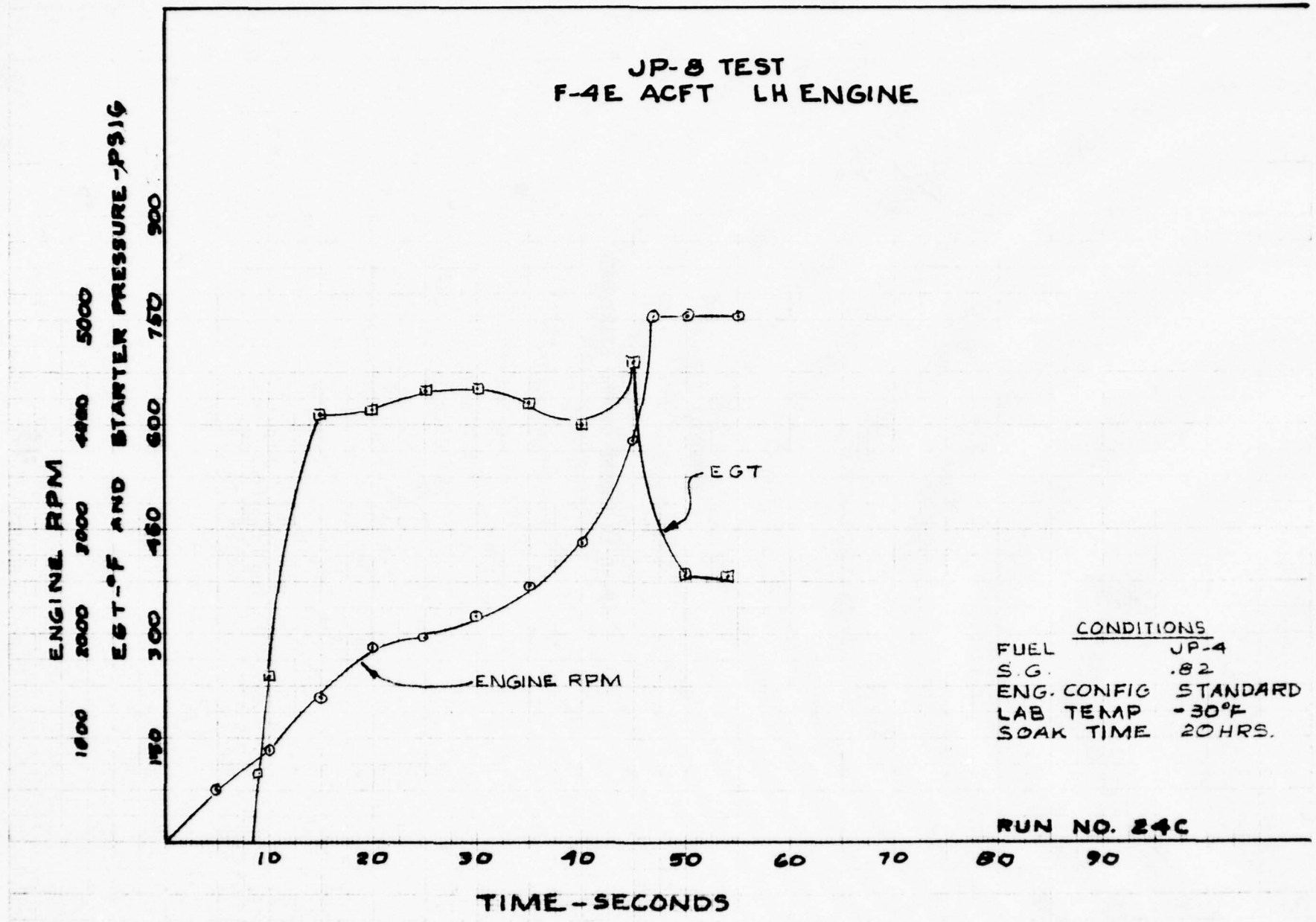

JP-8 TEST
F-4E ACFT LH ENGINE
EGT
ENGINE RPM
CONDITIONS
FUEL JP-8
SG .82
ENG CONFIG STANDARD
LAB TEMP -30°F
SOAK TIME 17 1/2 HRS
RUN NO. 19C
ENGINE RPM
E.G.T. °F AND STARTER PRESSURE - PSIG
TIME - SECONDS
1000
2000
3000
4000
5000
10
20
30
40
50
60
70
80
90
100


JP-8 TEST
F-4E ACFT LH ENGINE
E.G.T. °F AND STARTER PRESSURE - PSIG
ENGINE RPM
1000
2000
3000
4000
5000
150
300
450
600
750
900
1050
EGT
ENGINE RPM
NO STARTER PRESSURE RECORDING
CONDITIONS
FUEL JP-4
SG .78
ENG. CONFIG STANDARD
LAB TEMP. -10°F
SOAK TIME 60 HRS
RUN NO. 20C
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS


JP-8 TEST
F-4E ACFT LH ENGINE
EGT - °F AND STARTER PRESSURE PSIG
ENGINE RPM
1000
2000
3000
4000
5000
100
200
300
400
500
600
700
800
EGT
ENGINE RPM
STARTER PPESSURE NOT RECORDED
CONDITIONS
FUEL JP-4
S.G .78
ENG CONFIG STANDARD
LAB TEMP -20°F
SOAK TIME 17 3/4 HRS
RUN NO. 21C
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS


JP-8 TEST
F-4E ACFT LH ENGINE
ENGINE RPM
EGT - °F AND STARTER PRESSURE PSIG
1000
2000
3000
4000
5000
150
300
450
600
750
900
1050
EGT
ENGINE RPM
CONDITIONS
FUEL JP-4
S G .78
ENG CONFIG STANDARD
LAB TEMP -30°F
SOAK TIME 18 HRS
RUN NO. 28C
10
20
30
40
50
60
70
80
90
TIME - SECONDS


JP-8 TEST
F-4E ACFT LH ENGINE
ENGINE RPM
1000 2000 3000 4000 5000
EGT - °F AND STARTER PRESSURE - PSIG
150 300 450 600 750 900 1050
EGT
ENGINE RPM
STARTER PRESSURE MALFUNCTIONED
CONDITIONS
FUEL JP-4
SG .78
ENG CONFIG STANDARD
LAB TEMP -20°F
SOAK TIME
RUN NO. 28C
10 20 30 40 50 60 70 80 90 100
TIME - SECONDS

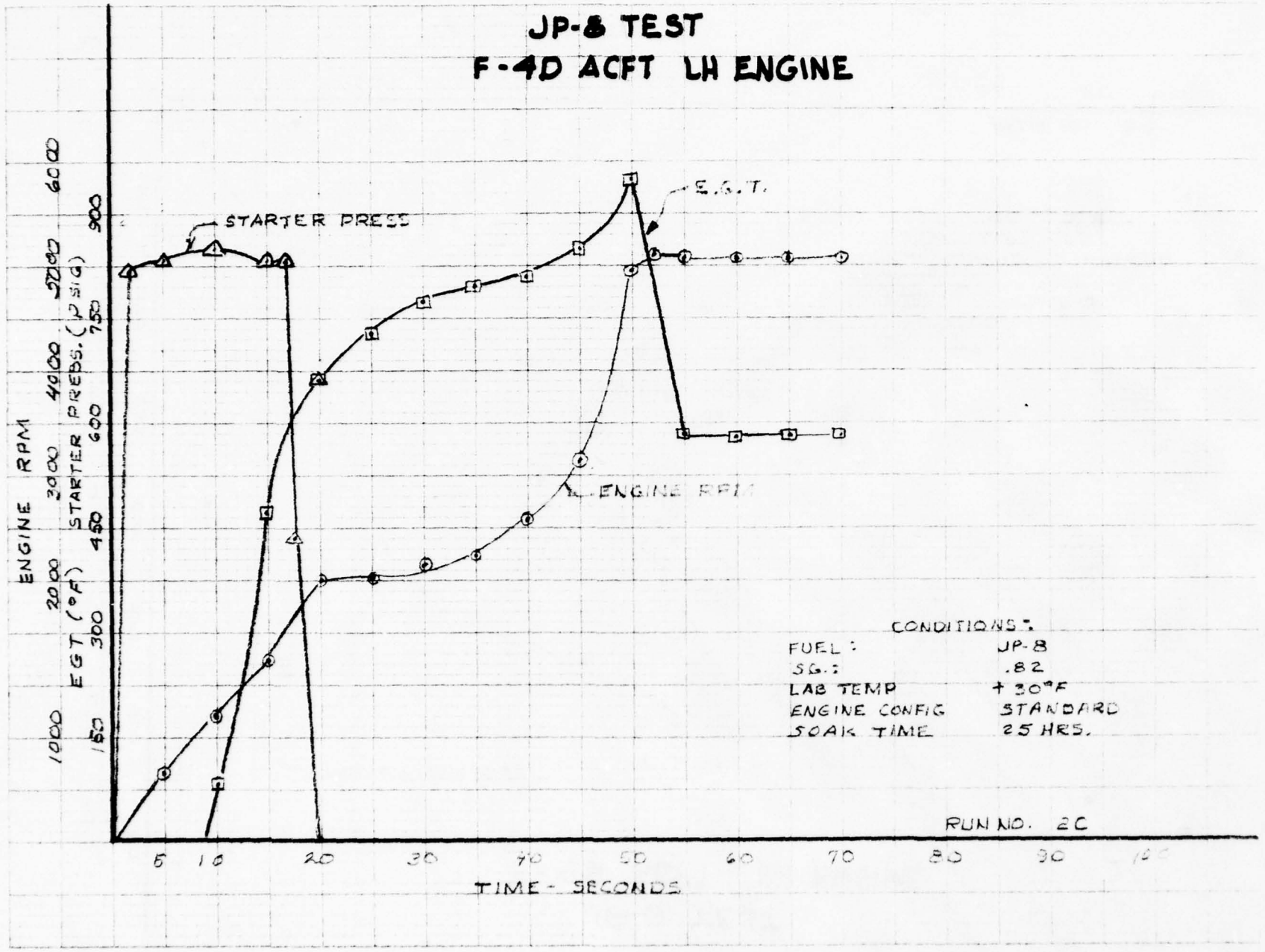

JP-8 TEST
F-4E ACFT LH ENGINE
ENGINE RPM
1000 2000 3000 4000 5000
EGT-°F AND STARTER PRESSURE-PSIG
150 300 450 600 750 900
EGT
ENGINE RPM
CONDITIONS
FUEL JP-4
S.G. .82
ENG. CONFIG STANDARD
LAB TEMP -30°F
SOAK TIME 20 HRS.
RUN NO. 24C
10 20 30 40 50 60 70 80 90
TIME-SECONDS

APPENDIX III

F-4D LH ENGINE GROUND START DATA

K&E 5 X 5 TO THE CENTIMETER 46 1512

JP-8 TEST
F-4D ACFT LH ENGINE



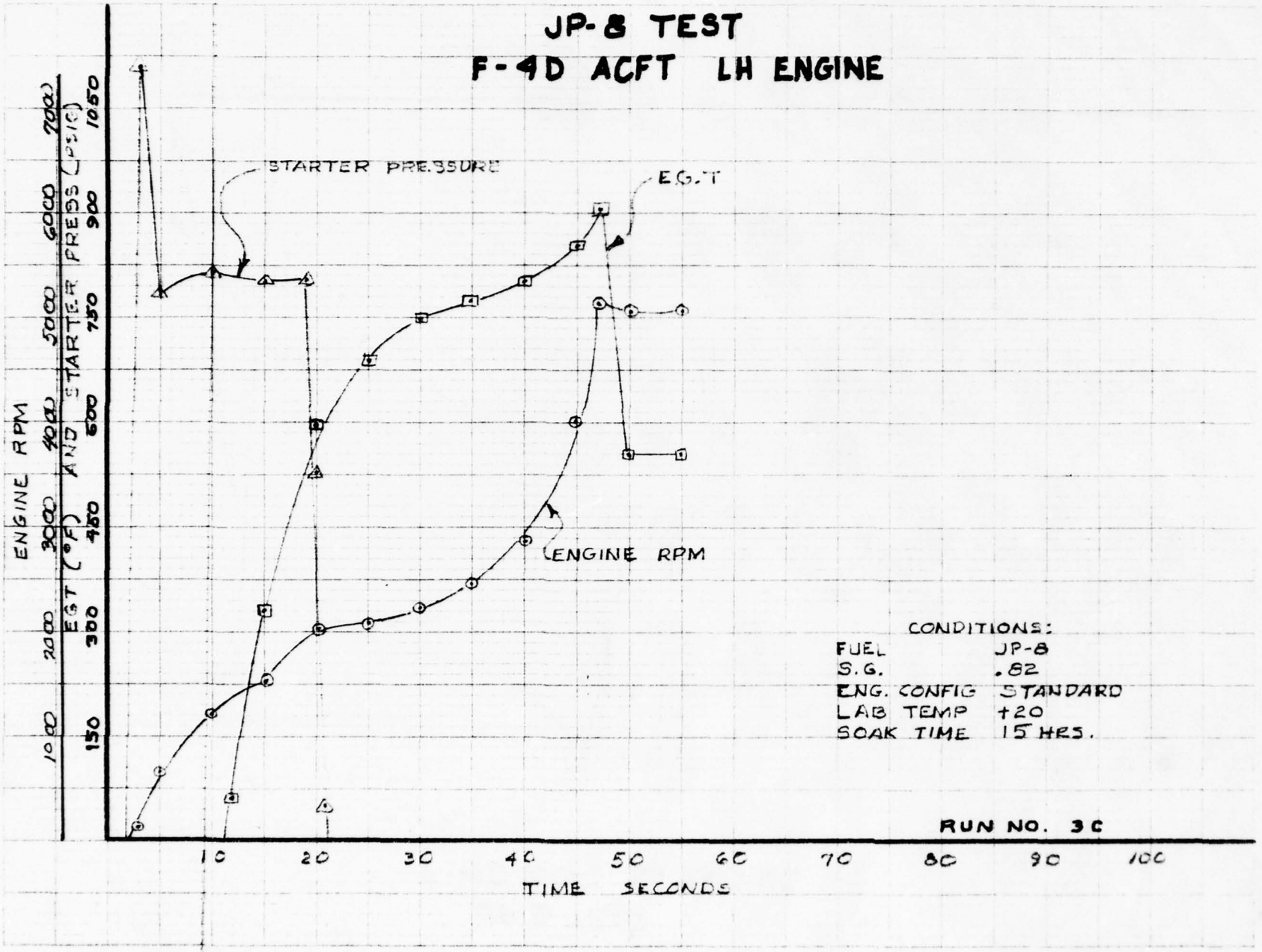
CONDITIONS:

FUEL:	JP-8
SG.:	.82
LAB TEMP	+ 30°F
ENGINE CONFIG	STANDARD
SOAK TIME	25 HRS.

RUN NO. 2C

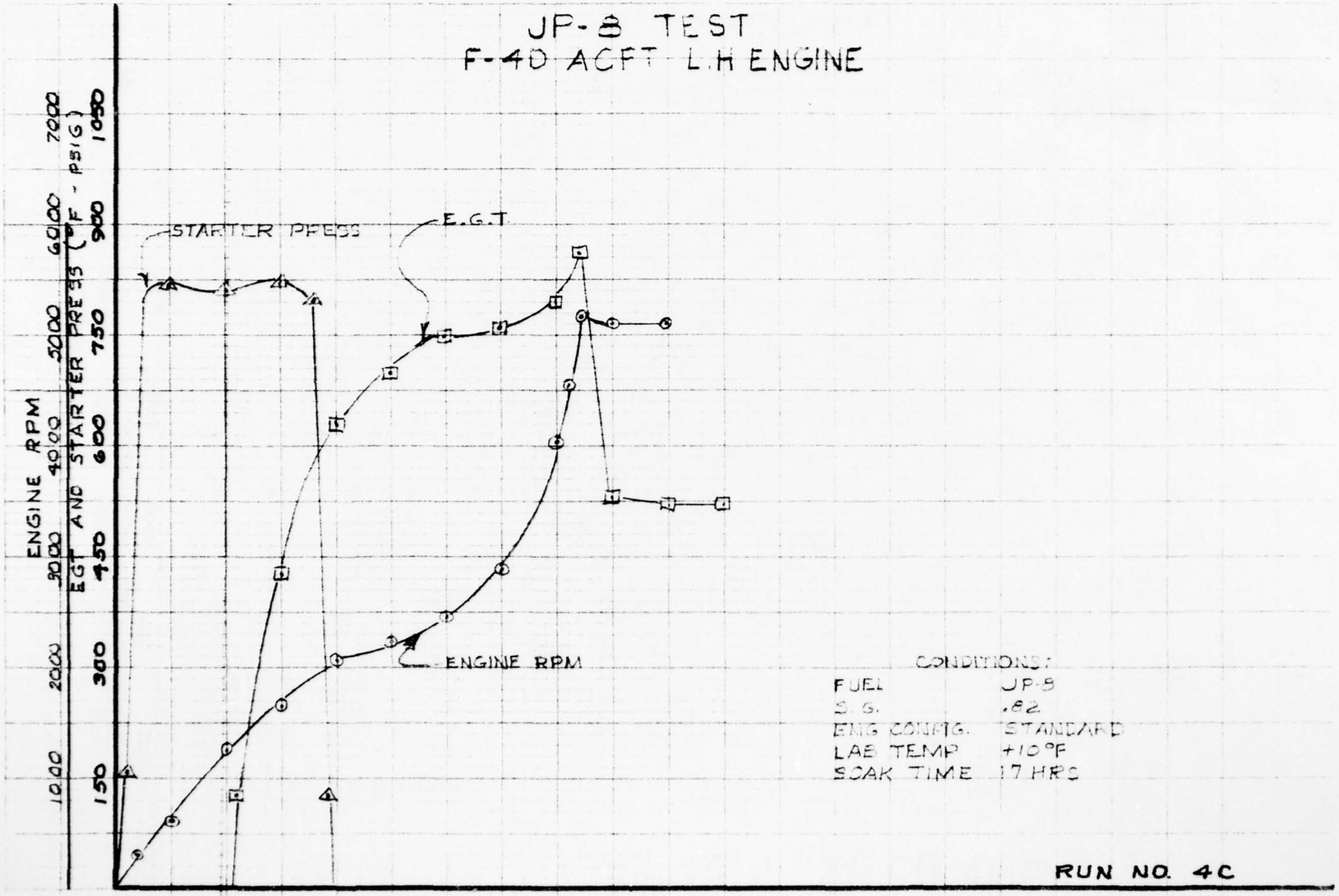
44

JP-8 TEST
F-4D ACFT LH ENGINE



5 X 5 TO THE CENTIMETER 46 1512

JP-8 TEST
F-4D ACFT L.H ENGINE

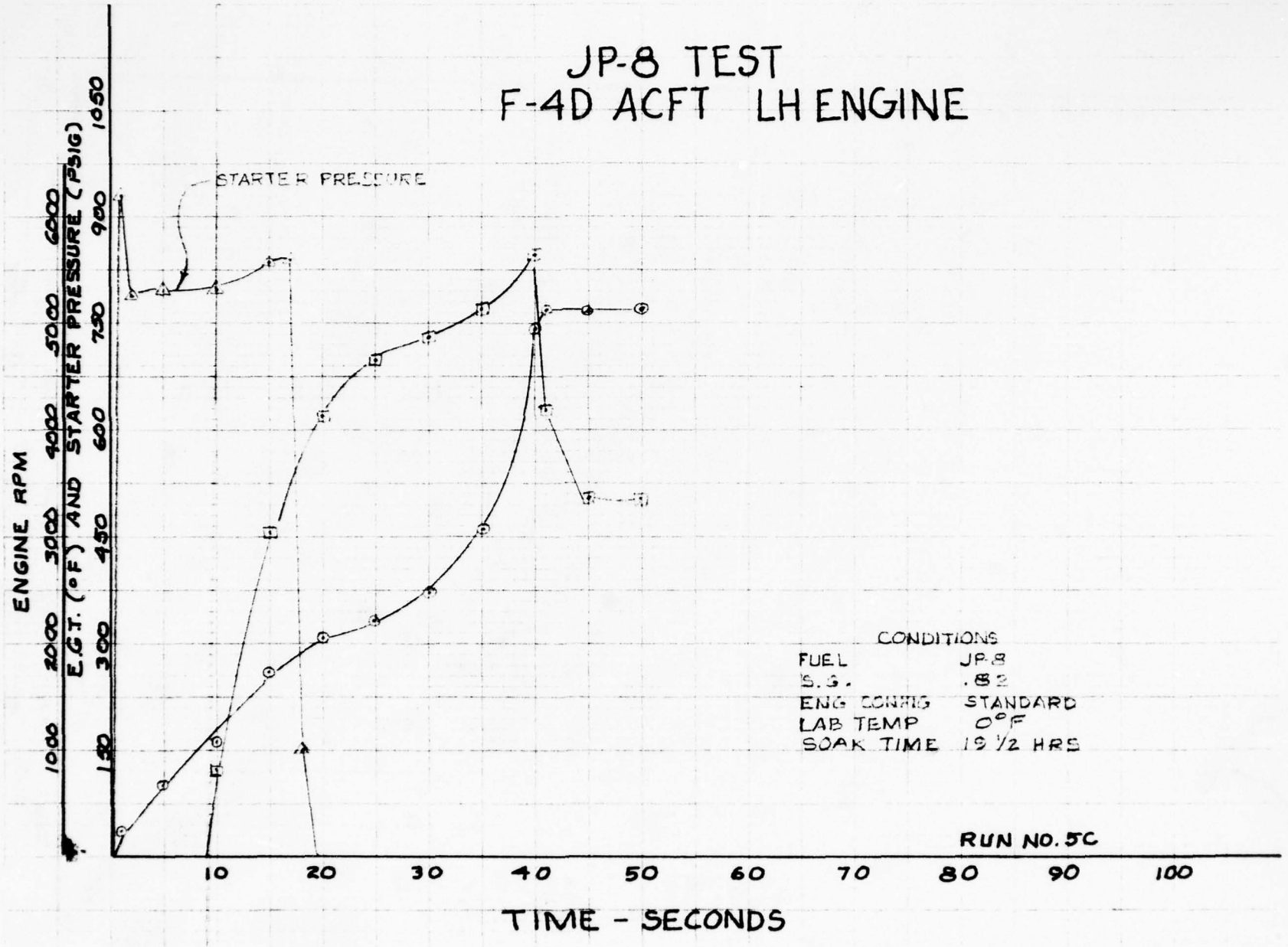


CONDITIONS:

FUEL	JP-8
S. G.	.82
ENG CONFIG.	STANDARD
LAB TEMP	+10°F
SOAK TIME	17 HRS

94

JP-8 TEST
F-4D ACFT LH ENGINE

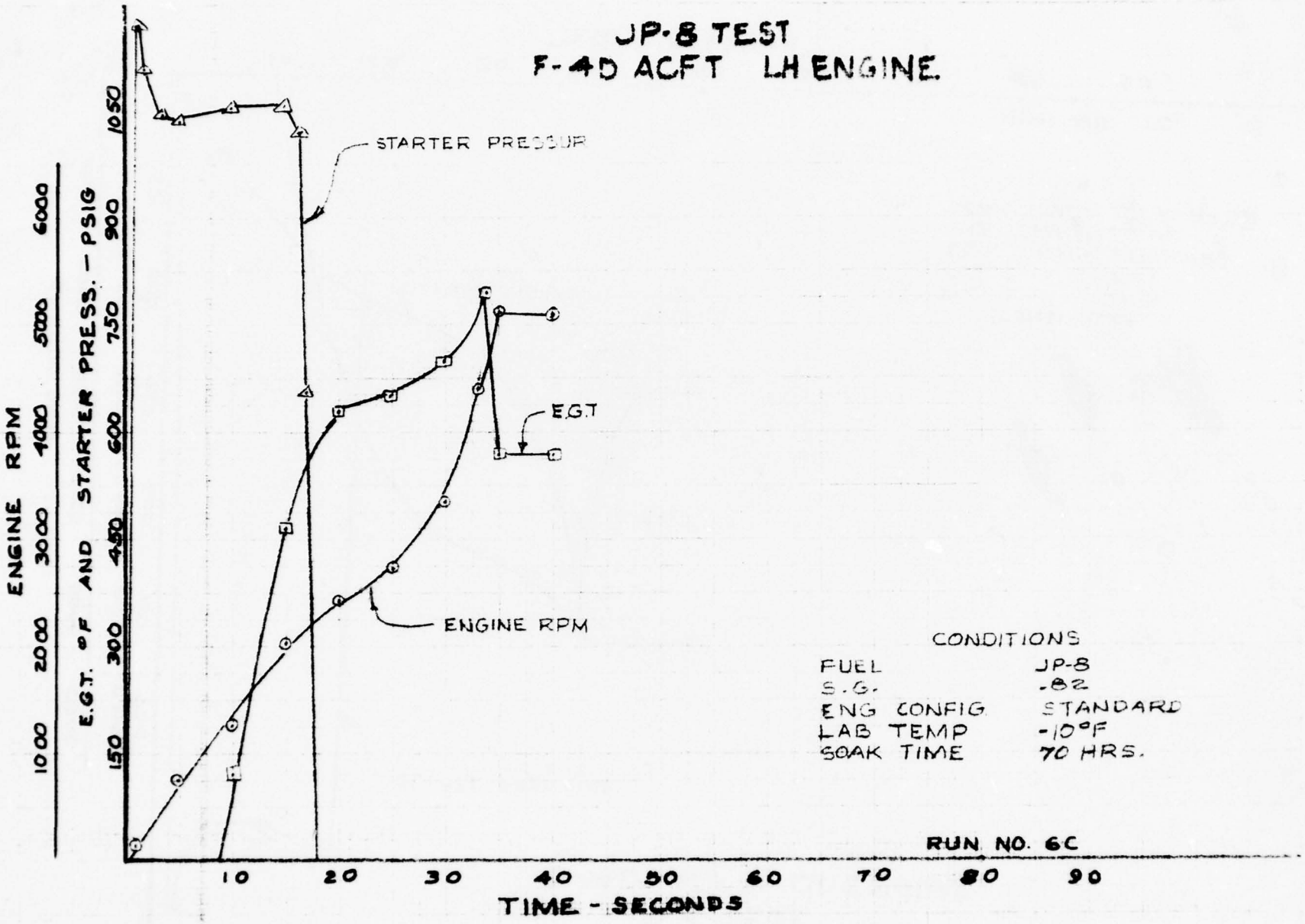


CONDITIONS

FUEL	JP-8
S.G.	.82
ENG CONFIG	STANDARD
LAB TEMP	0°F
SOAK TIME	19 1/2 HRS

RUN NO. 5C

JP-8 TEST
F-4D ACFT LH ENGINE.



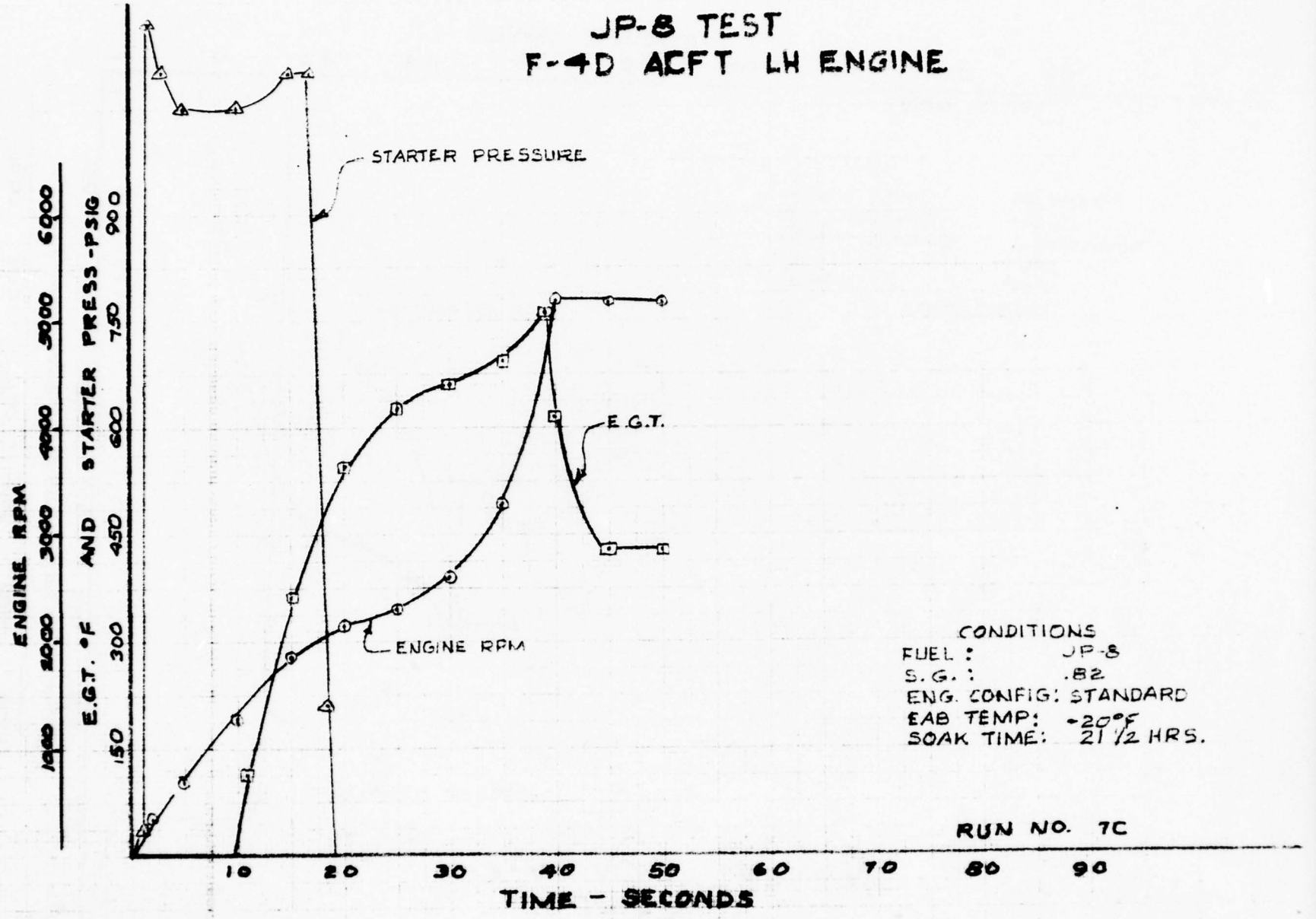
CONDITIONS

FUEL	JP-8
S.G.	.82
ENG CONFIG	STANDARD
LAB TEMP	-10°F
SOAK TIME	70 HRS.

RUN NO. 6C

84

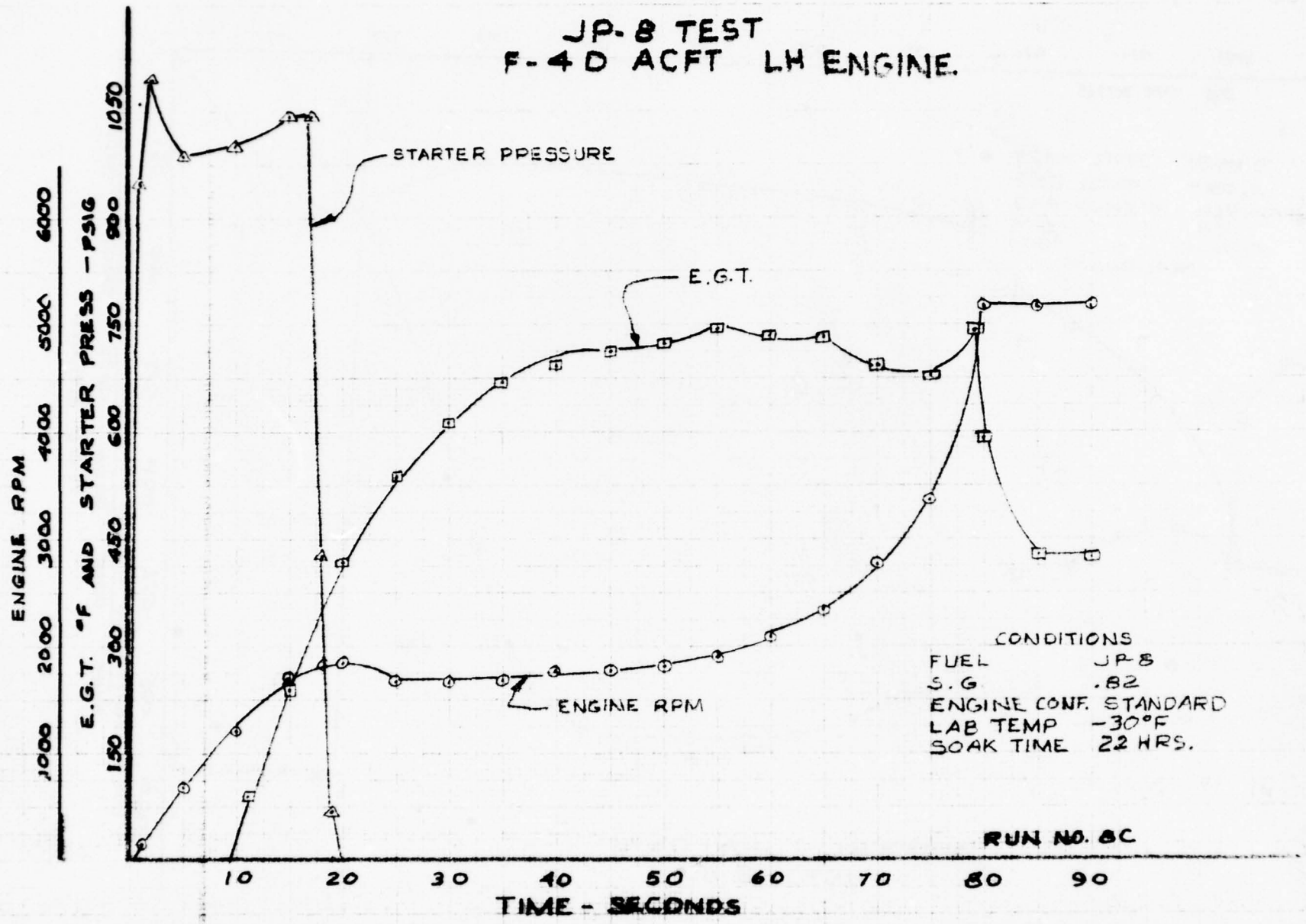
JP-8 TEST
F-4D ACFT LH ENGINE

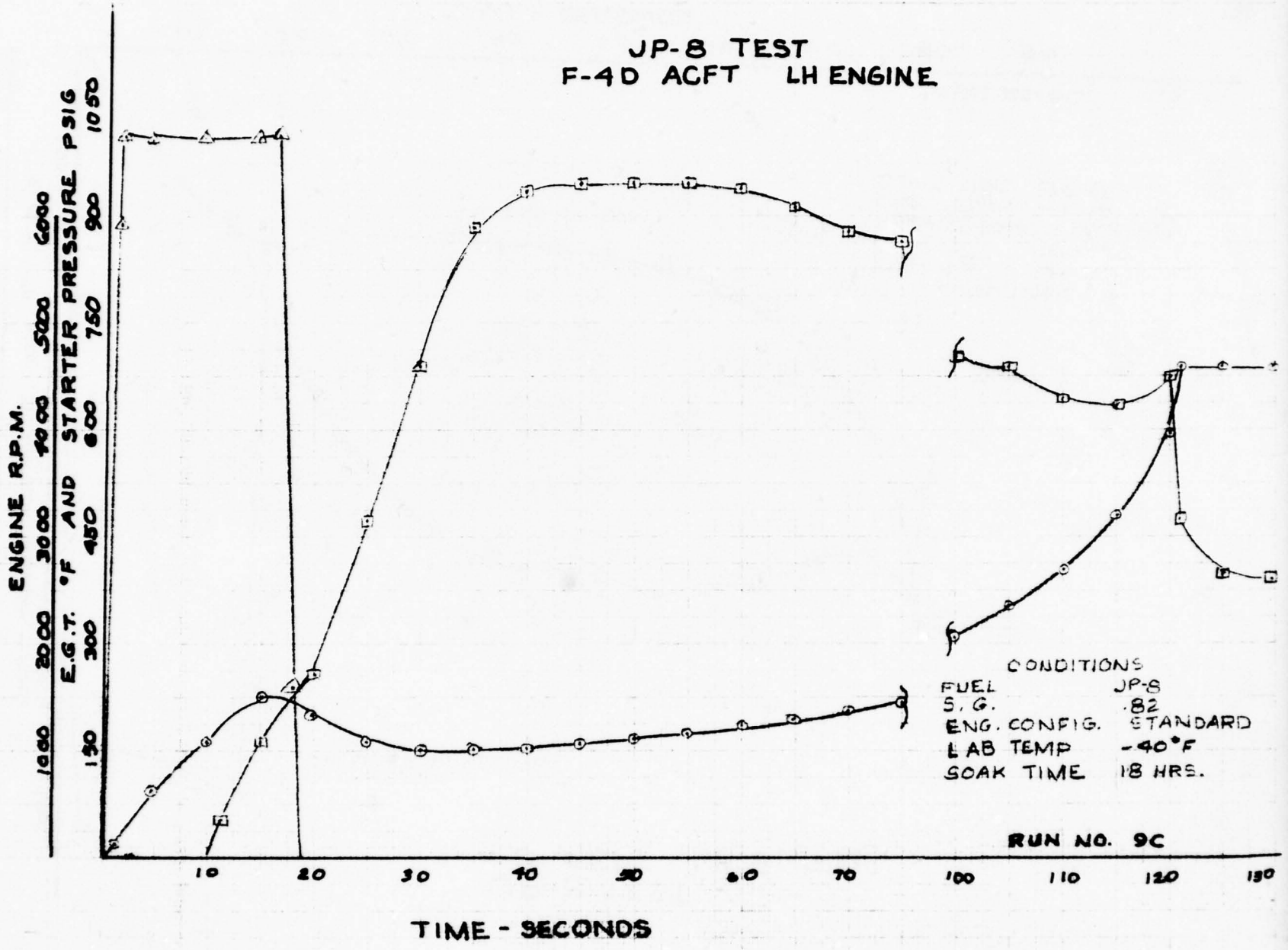


CONDITIONS
FUEL : JP-8
S.G. : .82
ENG. CONFIG: STANDARD
EAB TEMP: -20°F
SOAK TIME: 21 1/2 HRS.

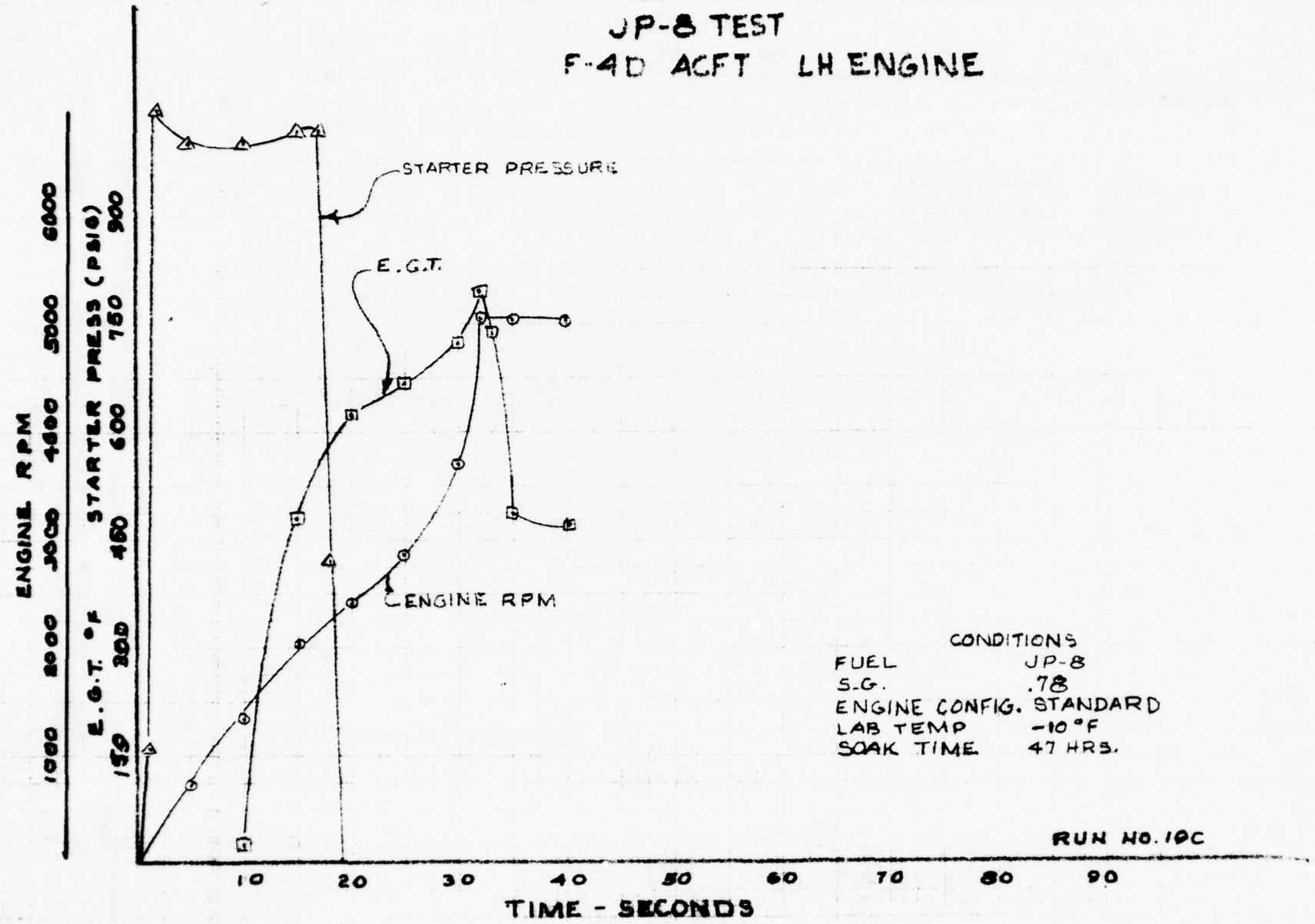
RUN NO. 7C

64


JP-8 TEST
F-4D ACFT LH ENGINE.
STARTER PRESSURE
E.G.T.
ENGINE RPM
E.G.T. °F AND STARTER PRESS - PSIG
ENGINE RPM
1000 2000 3000 4000 5000 6000
150 300 450 600 750 900 1050
10 20 30 40 50 60 70 80 90
TIME - SECONDS
CONDITIONS
FUEL JP-8
S.G .82
ENGINE CONF. STANDARD
LAB TEMP -30°F
SOAK TIME 22 HRS.
RUN NO. 8C


JP-8 TEST
F-4D ACFT LH ENGINE
ENGINE R.P.M.
1000 2000 3000 4000 5000 6000
E.G.T. °F AND STARTER PRESSURE PSIG
150 300 450 600 750 900 1050
CONDITIONS
FUEL JP-8
S. G. .82
ENG. CONFIG. STANDARD
LAB TEMP -40°F
SOAK TIME 18 HRS.
RUN NO. 9C
10 20 30 40 50 60 70 100 110 120 130
TIME - SECONDS

JP-8 TEST
F-4D ACFT LH ENGINE

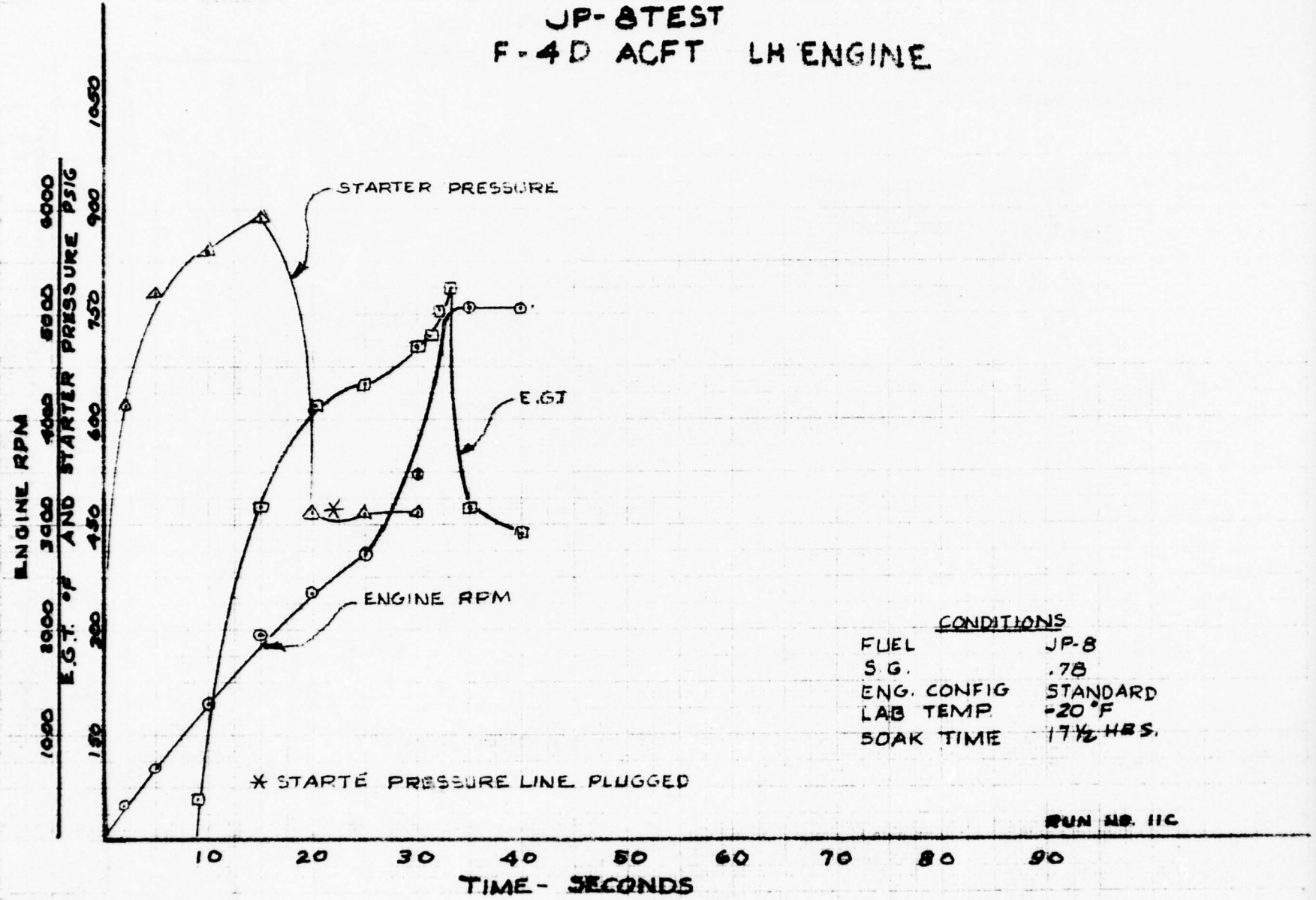


CONDITIONS

FUEL	JP-8
S.G.	.78
ENGINE CONFIG.	STANDARD
LAB TEMP	-10 °F
SOAK TIME	47 HRS.

RUN NO. 19C

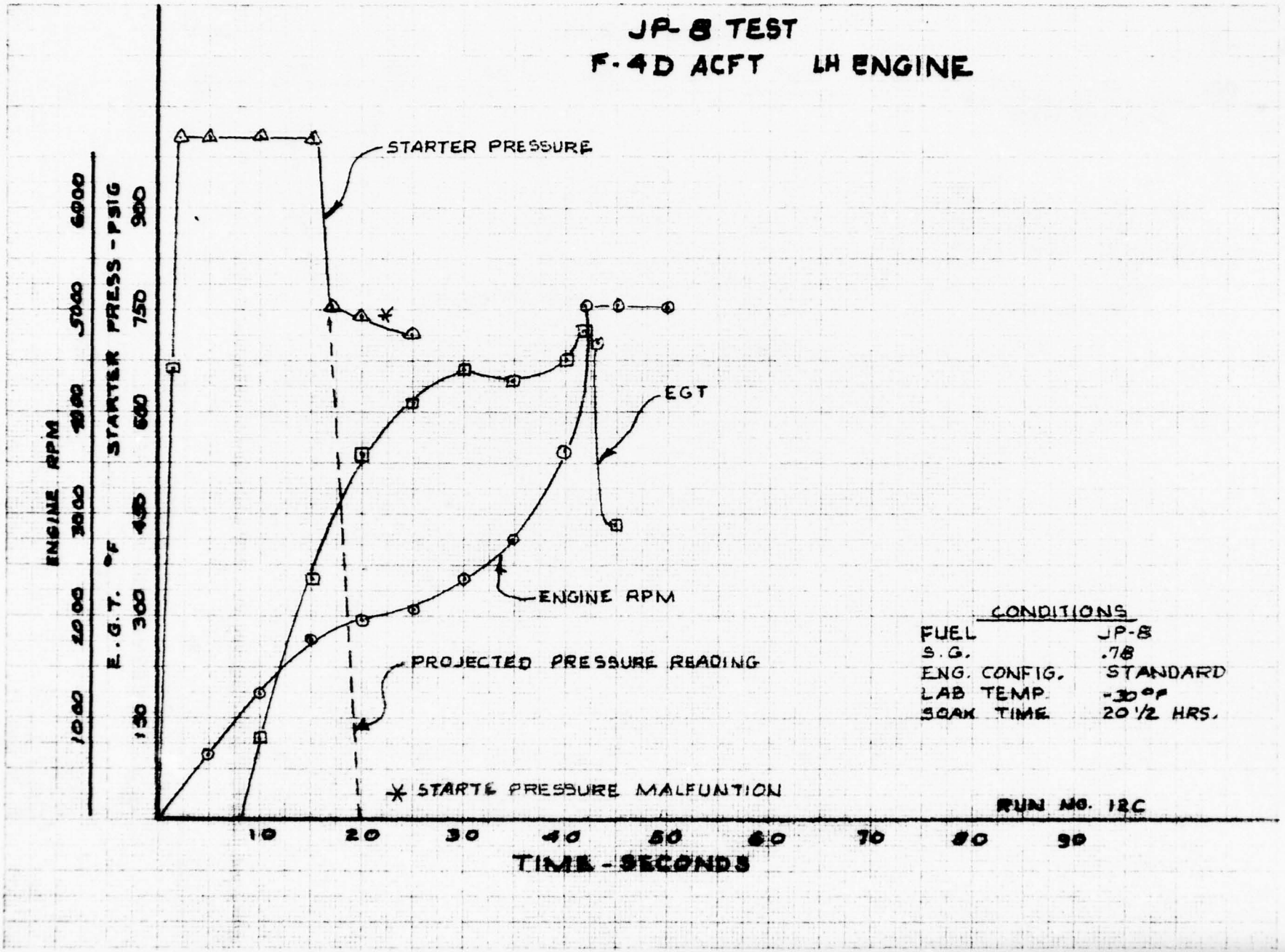
JP-8 TEST
F-4D ACFT LH ENGINE

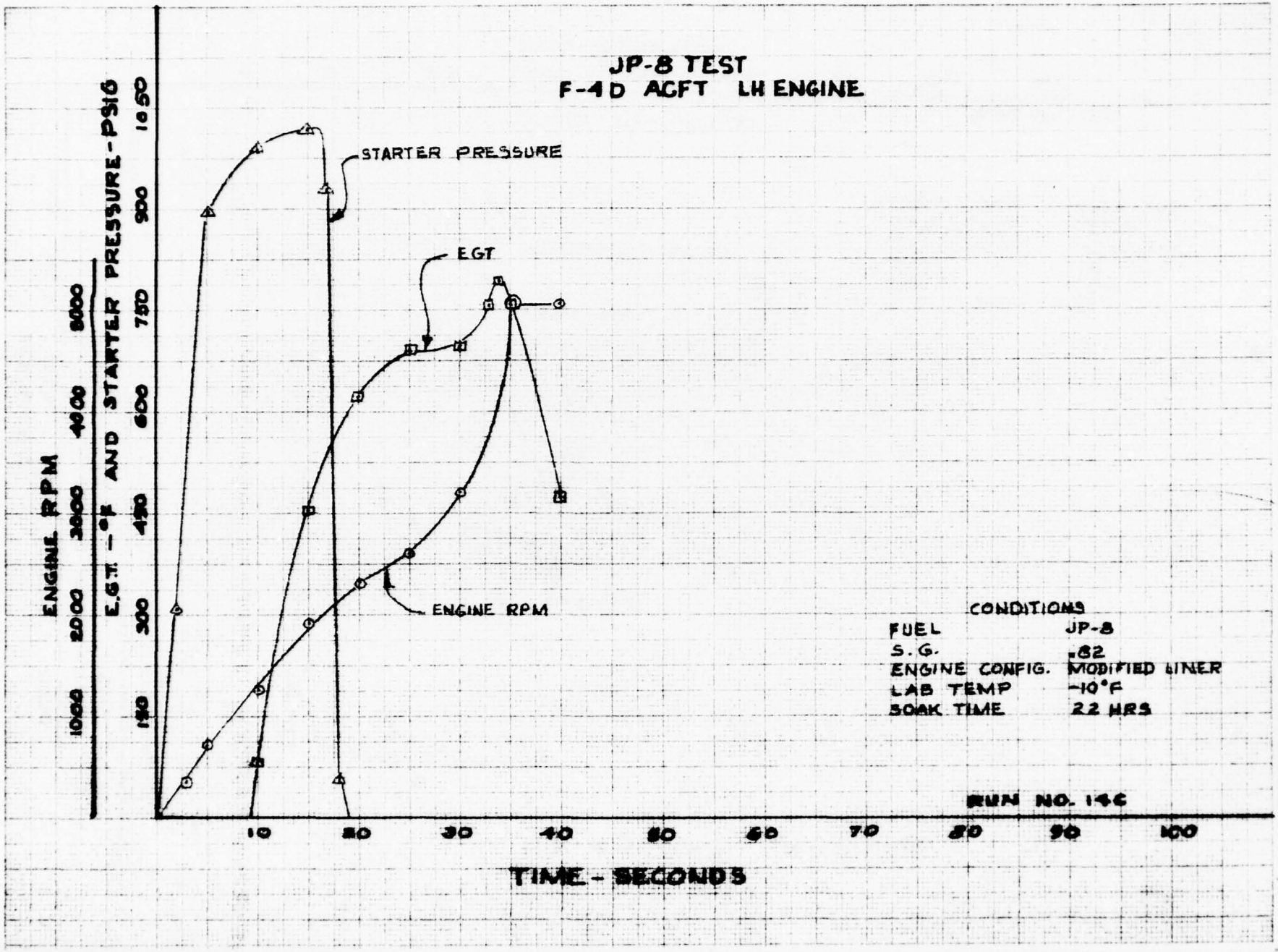


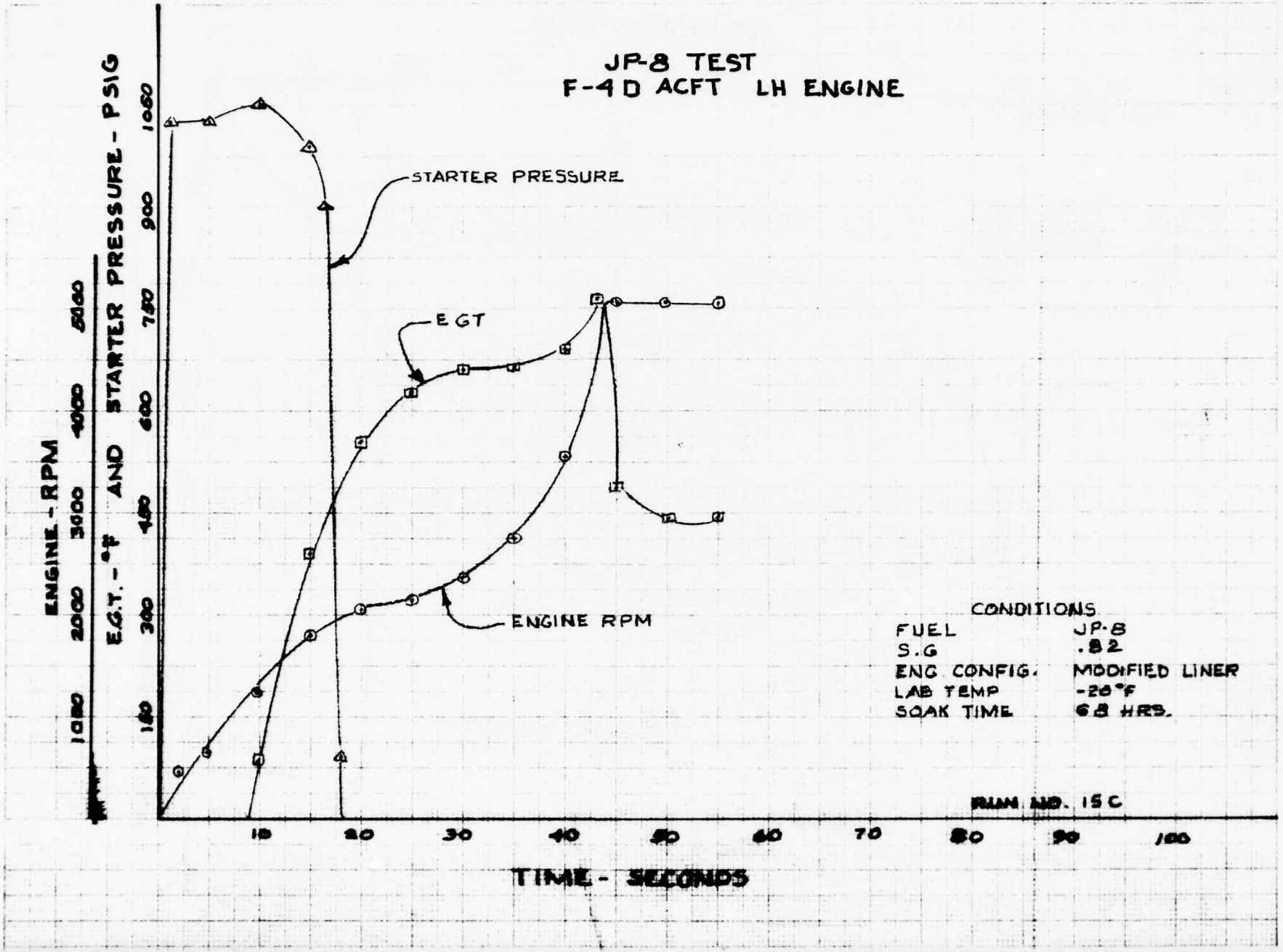
CONDITIONS

FUEL	JP-8
S.G.	.78
ENG. CONFIG	STANDARD
LAB TEMP	-20 °F
SOAK TIME	17½ HRS.

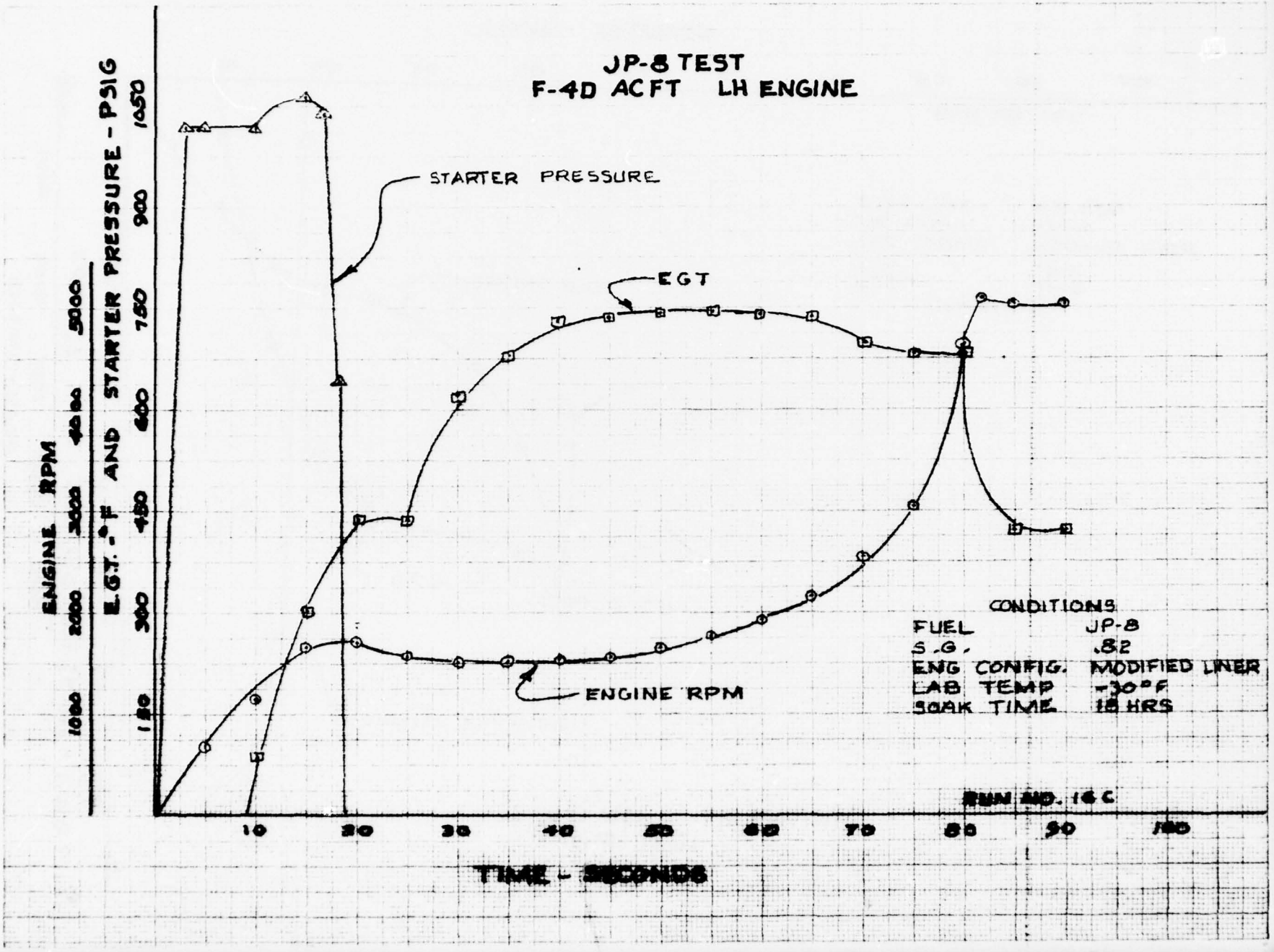
RUN NO. 11C

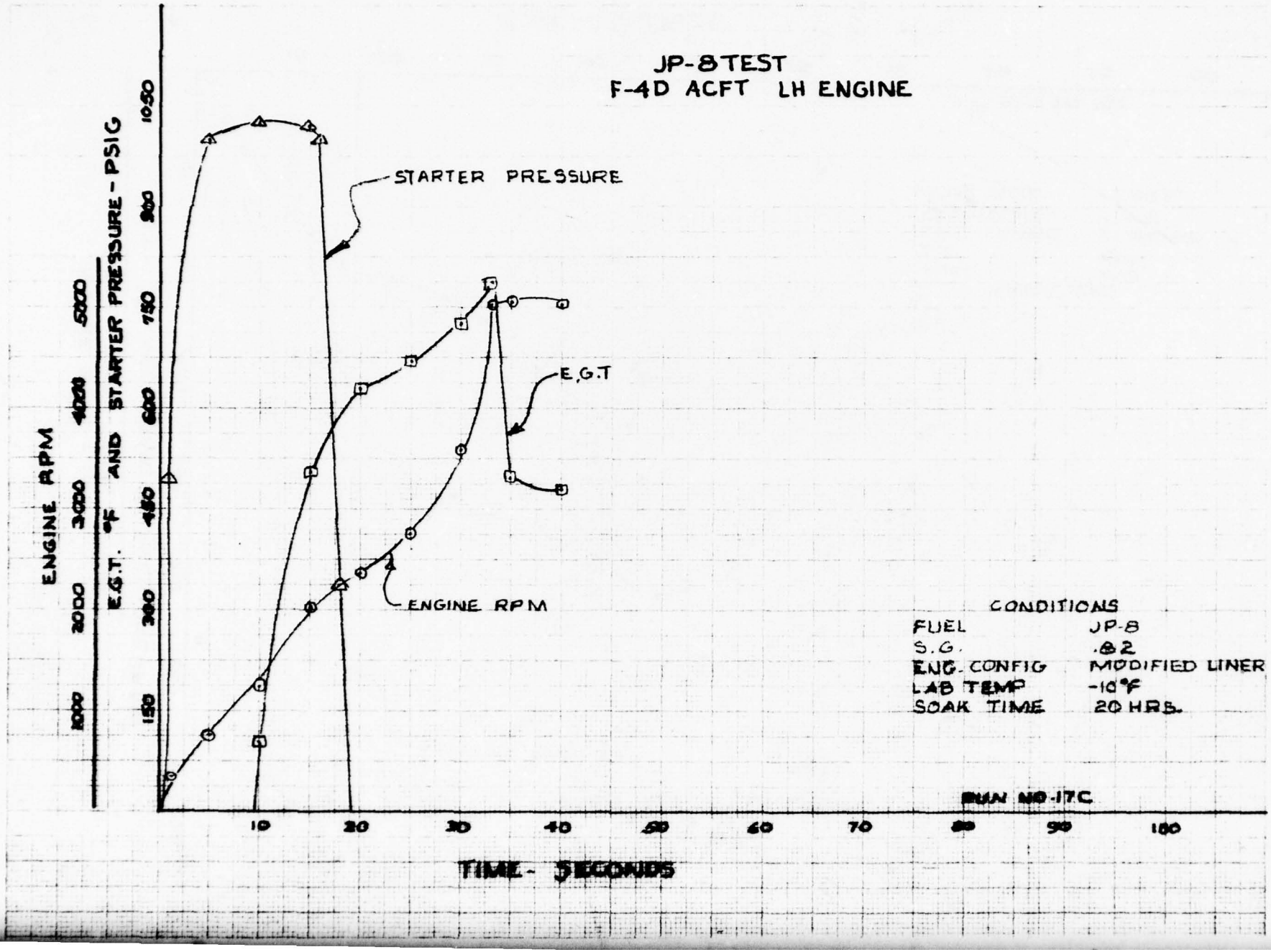

JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
PROJECTED PRESSURE READING
* STARTER PRESSURE MALFUNTION
ENGINE RPM
E.G.T. °F
STARTER PRESS - PSIG
TIME - SECONDS
CONDITIONS
FUEL JP-8
S.G. .78
ENG. CONFIG. STANDARD
LAB TEMP. -30°F
SOAK TIME 20 1/2 HRS.
RUN NO. 12C

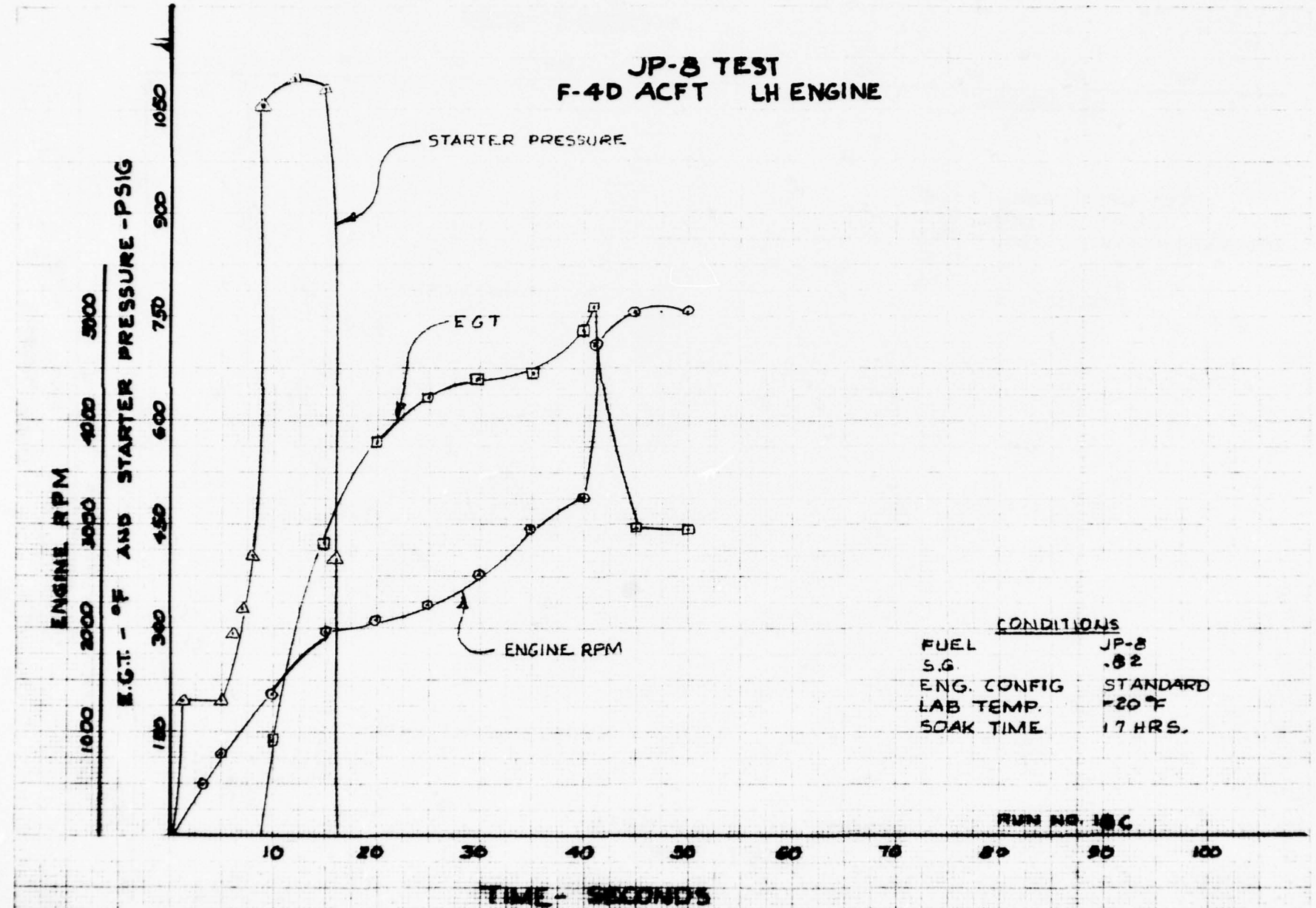

JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
E.G.T. - °F AND STARTER PRESSURE - PSIG
ENGINE RPM
1000
2000
3000
4000
5000
150
300
450
600
750
900
1050
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS
CONDITIONS
FUEL JP-8
S.G. .82
ENGINE CONFIG. MODIFIED LINER
LAB TEMP -10°F
SOAK TIME 22 HRS
RUN NO. 146

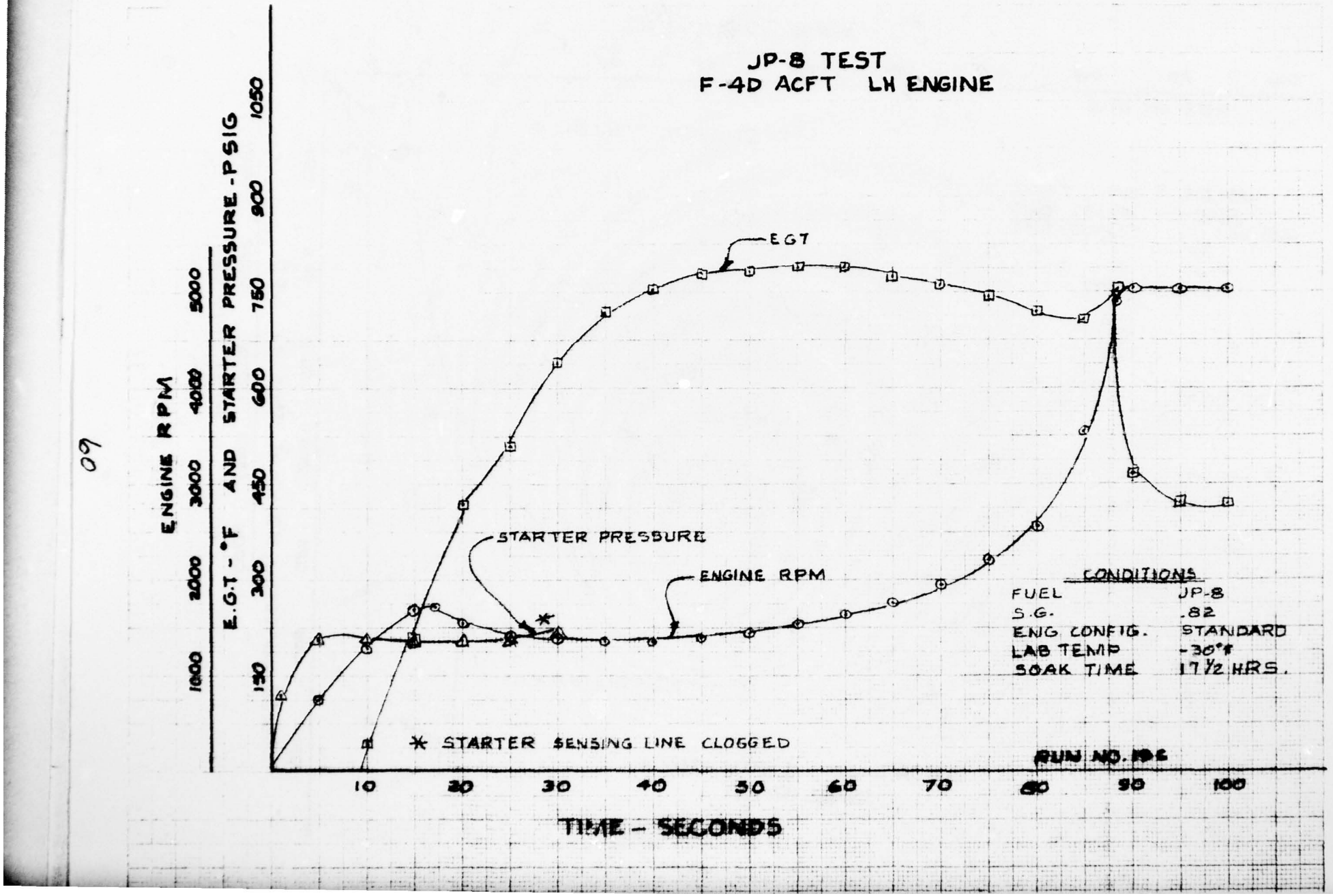

JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
ENGINE - RPM
E.G.T. - °F AND STARTER PRESSURE - PSIG
TIME - SECONDS
CONDITIONS
FUEL JP-8
S.G .82
ENG CONFIG. MODIFIED LINER
LAB TEMP -20°F
SOAK TIME 6.8 HRS.
RUN NO. 15C

95

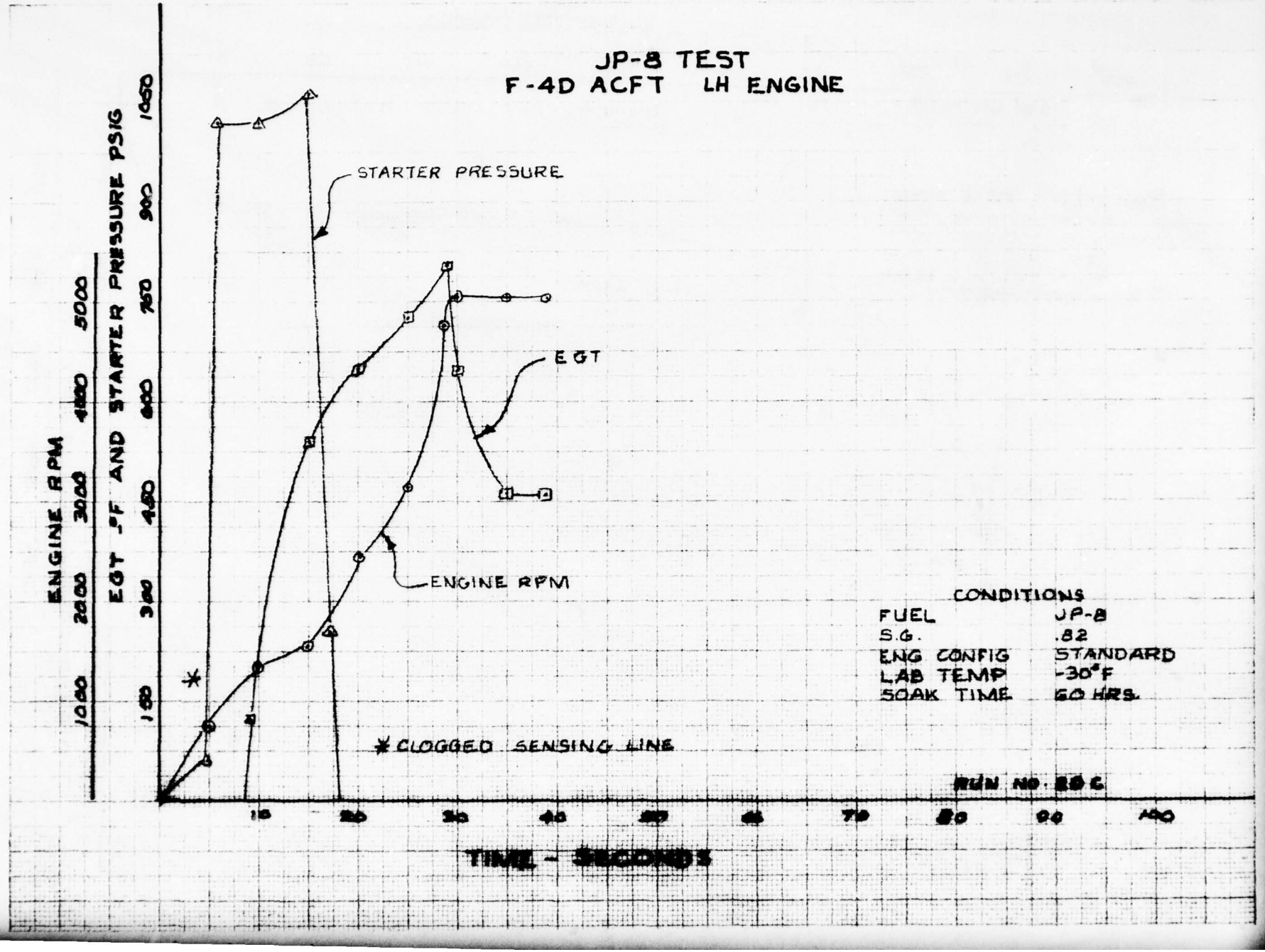

JP-8 TEST
F-4D AC FT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
E.G.T. - °F AND STARTER PRESSURE - PSIG
ENGINE RPM
1050
900
750
600
450
300
150
5000
4000
3000
2000
1000
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS
RUN NO. 16C
CONDITIONS
FUEL JP-8
S.G. .82
ENG CONFIG. MODIFIED LINER
LAB TEMP -30°F
SOAK TIME 18 HRS

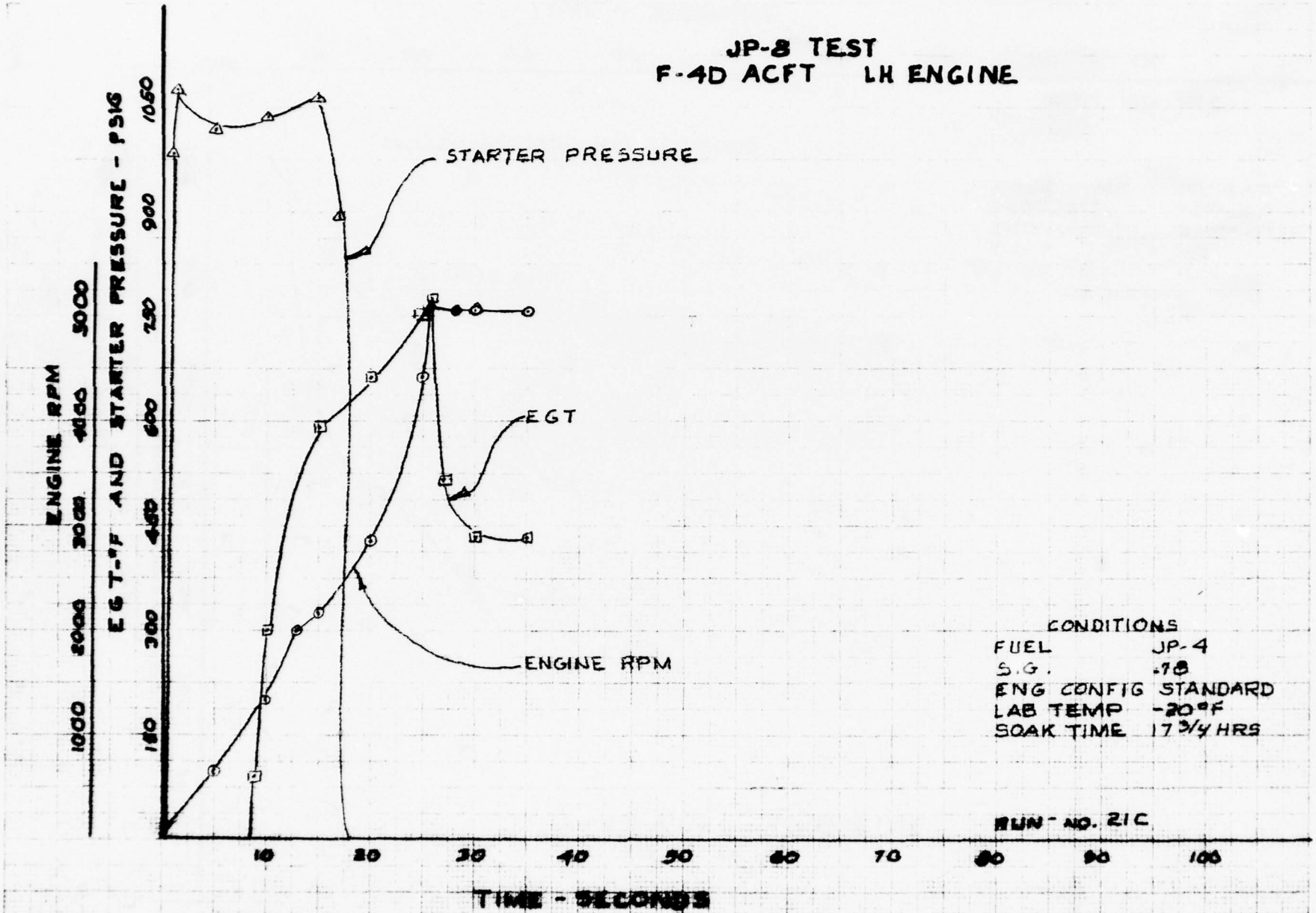

JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
E.G.T
ENGINE RPM
ENGINE RPM
E.G.T. °F AND STARTER PRESSURE - PSIG
TIME - SECONDS
CONDITIONS
FUEL JP-8
S.G. .82
ENG. CONFIG MODIFIED LINER
LAB TEMP -10°F
SOAK TIME 20 HRS.
RUN NO-17C
1000
2000
3000
4000
5000
150
300
450
600
750
900
1050
10
20
30
40
50
60
70
80
90
100


JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
E.G.T. - °F AND STARTER PRESSURE - PSIG
ENGINE RPM
1000
2000
3000
4000
5000
1050
900
750
600
450
300
150
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS
CONDITIONS
FUEL JP-8
S.G. .82
ENG. CONFIG STANDARD
LAB TEMP. -20°F
SOAK TIME 17 HRS.
RUN NO. 18C

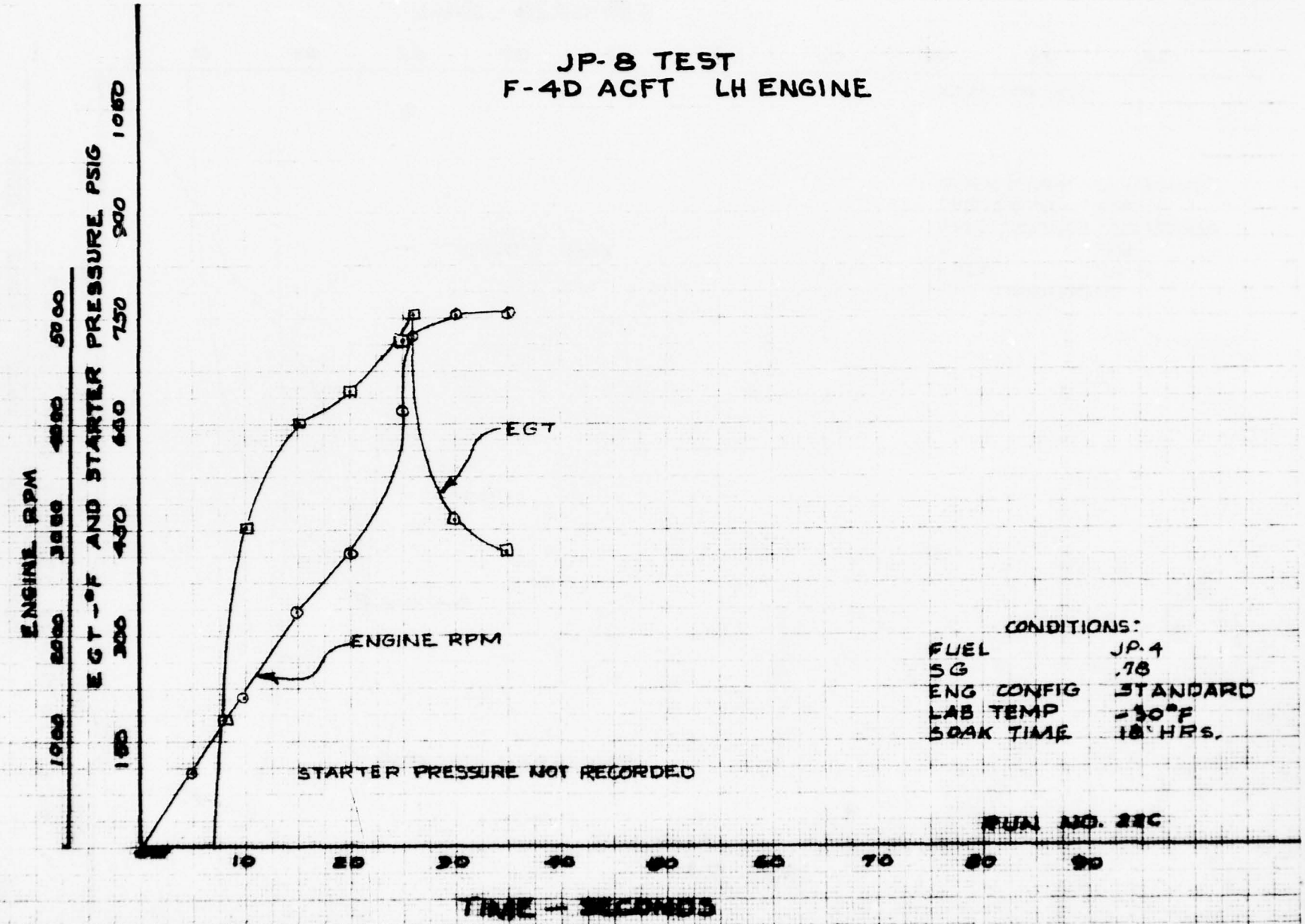

JP-8 TEST
F-4D ACFT LH ENGINE
ENGINE RPM
1000
2000
3000
4000
5000
E.G.T. - °F AND STARTER PRESSURE - PSIG
150
300
450
600
750
900
1050
EGT
STARTER PRESSURE
ENGINE RPM
CONDITIONS
FUEL JP-8
S.G. .82
ENG CONFIG. STANDARD
LAB TEMP -30°F
SOAK TIME 17½ HRS.
* STARTER SENSING LINE CLOGGED
RUN NO. 106
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS

09


JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
* CLOGGED SENSING LINE
CONDITIONS
FUEL JP-8
S.G. .82
ENG CONFIG STANDARD
LAB TEMP -30°F
SOAK TIME 60 HRS.
RUN NO. 80 C
ENGINE RPM
EGT °F AND STARTER PRESSURE PSIG
TIME - SECONDS


JP-8 TEST
F-4D ACFT LH ENGINE
STARTER PRESSURE
EGT
ENGINE RPM
EGT-°F AND STARTER PRESSURE - PSIG
ENGINE RPM
1000
2000
3000
4000
5000
150
300
450
600
750
900
1050
10
20
30
40
50
60
70
80
90
100
TIME - SECONDS
CONDITIONS
FUEL JP-4
S.G. .78
ENG CONFIG STANDARD
LAB TEMP -20°F
SOAK TIME 17 3/4 HRS
RUN - NO. 21C

JP-8 TEST
F-4D ACFT LH ENGINE

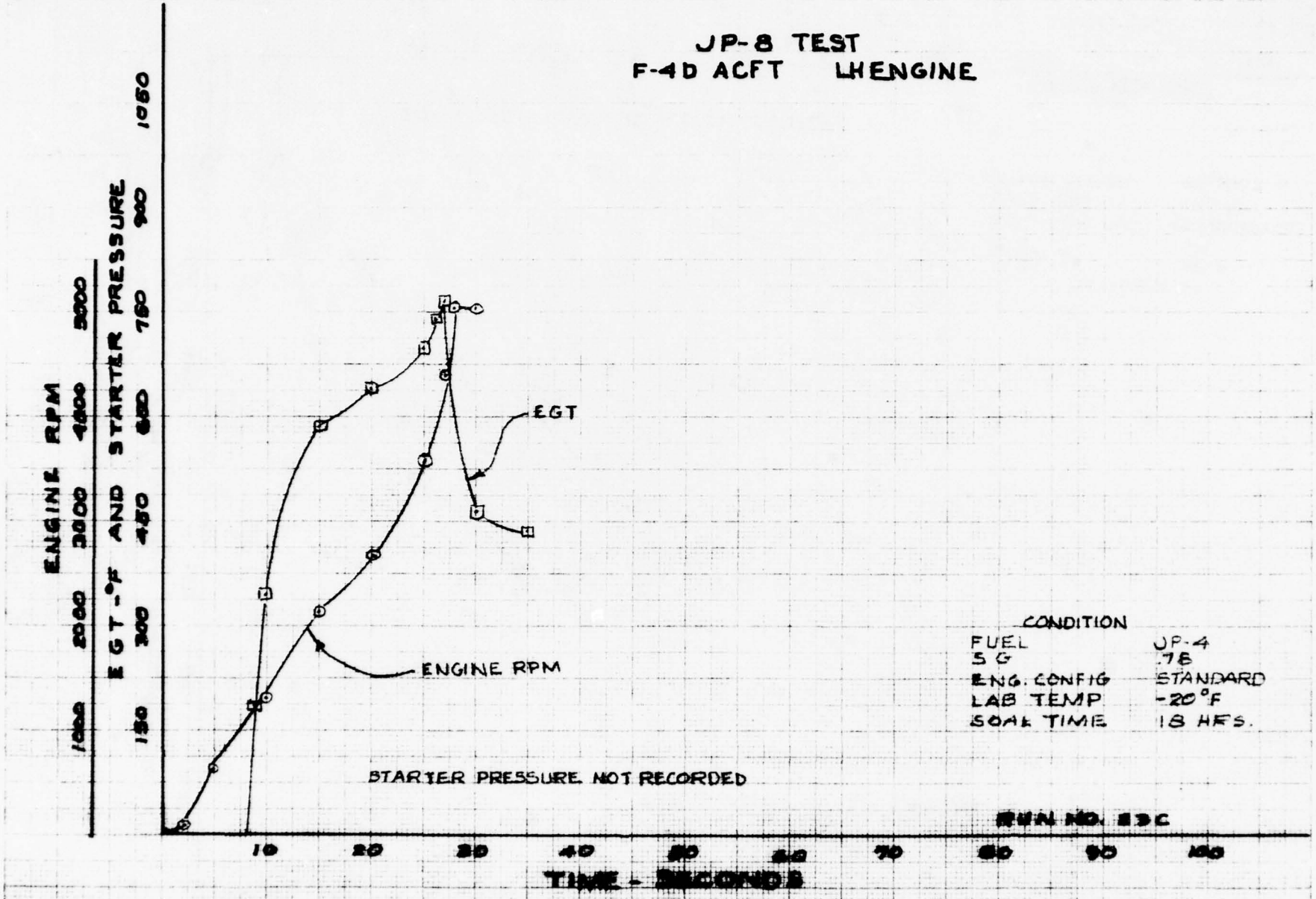


CONDITIONS:

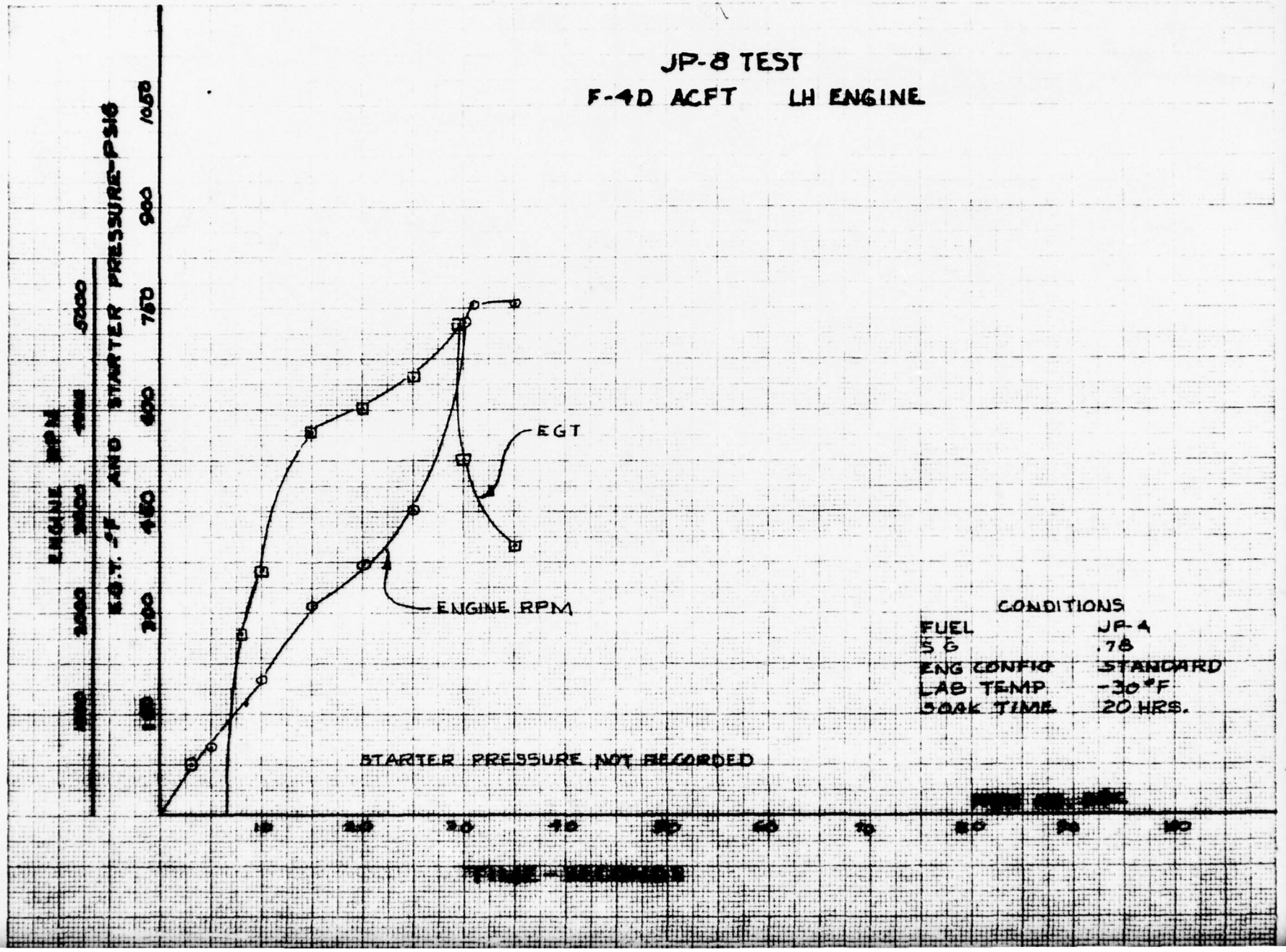
FUEL	JP-4
SG	.78
ENG CONFIG	STANDARD
LAB TEMP	-30°F
SOAK TIME	18 HRS.

RUN NO. 22C

JP-8 TEST
F-4D ACFT LH ENGINE



JP-8 TEST
F-4D ACFT LH ENGINE



APPENDIX IV

F-4E AND F-4D ENGINE STARTING TIME AND RUN DATA

ENGINE CONFIGURATION, TEMP, FUEL AND Date test completed

NO OF RUNS	SPECIFIC GRAVITY SETTING	START MODE	TYPE OF FUEL	CLIMATIC CHAMBER TEMP OF	J79-15 J79-17 RH	J79-15 J79-17 LH	ENGINE/AIRCRAFT CONFIGURATION	DATE COMPLETED	TIME OF DAY
14	0.82	CART PNEU	JP-8 DELETED	-10	Modified Liner & HEI	Modified Liner	C/B No 2 Ignition Pulled	28 JULY	1400
15		CART PNEU		-20				31 JULY 31 JULY	0830 1430
16		CART PNEU		-30				1 AUG 1 AUG	0830 1420
17	0.82	CART PNEU	JP-8	-10	HEI	Standard Configuration	C/B No 2 Ignition pulled on RH Engine C/B No 1 Ignition pulled on LH Engine	2 AUG. 2 AUG	1030 1430
18		CART PNEU		-20				3 AUG 3 AUG	0800 1430
19		CART PNEU	DELETED	-30				4 AUG	0830
20	0.78	CART PNEU	JP-4	-10	Standard Configuration	Standard Configuration	C/B No 1 Ignition Pulled	7 AUG 7 AUG	0830 1430
21		CART PNEU		-20				8 AUG 8 AUG	0800 1430
22		CART PNEU		-30				9 AUG 9 AUG	0820 1430

* On first run we failed to pull C/B No 1 ignition on LH engine; therefore, we tested the engine in modified liner configuration.

23	.82	CART PNEU	JP-4	-20	Standard Configuration	Standard Configuration	C/B No. 1 Ignition pulled	10 AUG 10 AUG	0830 1430
24	.82	CART PNEU	JP-4 DELETED	-30	"	"	"	11 AUG	1100

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ENGINE CONFIGURATION, TEMP., FUEL AND DATE TEST COMPLETED

NO OF RUNS	SPECIFIC GRAVITY SETTING	START MODE	TYPE OF FUEL	CLIMATIC CHAMBER TEMP OF	J79-15 J79-17 RH	J79-15 J79-17 LH	ENGINE/AIRCRAFT CONFIGURATION	DATE COMPLETED	TIME OF DAY
1	0.82	CART PNEU	JP-8	40	Standard Configuration	Standard Configuration	C/B No 1 Ignition Pulled	10 JULY 10 JULY	0830 1500
2		CART PNEU	DELETED	30				11 JULY —	1600 —
3		CART PNEU		20				12 JULY 12 JULY	0800 1430
4		CART PNEU		10				13 JULY 13 JULY	0800 1430
5		CART PNEU		0				14 JULY 14 JULY	0800 1500
6		CART PNEU	DELETED	-10				17 JULY —	1600 —
7		CART PNEU		-20 0				18 JULY 19 JULY	1230 1430
8		CART PNEU	DELETED	-30				20 JULY —	1400 —
9		CART PNEU	DELETED	-40				21 JULY —	0800 —
10	0.78	CART PNEU	JP-8	-10	Standard Configuration	Standard Configuration	C/B No 1 Ignition Pulled	24 JULY 24 JULY	0900 1430
11		CART PNEU		-20				25 JULY 26 JULY	0800 1400
12		CART PNEU		-30				26 JULY 26 JULY	1015 1430
13	0.82	CART PNEU	JP-8	-40				27 JULY 27 JULY	1030 1400

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STARTING RESULTS

STARTING MODE	RUN NO.	DATE	F-4D		F-4E		LAB TEMP	
			RH #2	LH #1	RH #2	LH #1		
CARTRIDGE	1C	10 Jul	S	No Eng Start	S	NO CART IGN	+40°F	LH (on F-4E) Starter Breech Cap was bad
PNEU	1P	10 Jul	S	S	S	NO CART IGN	+40°F	Repaired bad ignitor on LH Engine, F-4E
CARTRIDGE	2C	11 Jul	S	S	S	S	+30°F	Stopped at idle and shut engine d
CARTRIDGE	3C	12 Jul	S	S	S	S	+20°F	
PNEU	3P	12 Jul	S	S	S	S	+20°F	F-4E Hyd Leaks F-4D Fuel Leaks
CARTRIDGE	4C	13 Jul	S	S	S	S	10	F-4D fuel leak stopped
PNEU	4P	13 Jul	S	S	S	S	10	Hyd Seapage has not increased
CARTRIDGE	5C	14 Jul	S	S	S	S	0	Hyd leaks increased
PNEU	5P	14 Jul	S	S	S	S	- 0	
CARTRIDGE	6C	17 Jul	S	S	S	S	-10	Only minor hyd leaks over the weekend
CARTRIDGE	7C	18 Jul	S	S	S	failed to start	-20	on LH Eng F-4E we suspect eng shut off failed to open completely
PNEU	7P	19 Jul	S	S	S	S	0	Because we had to repair hyd leaks we were unable to cold soak the [illegible]
CARTRIDGE	8C	20 Jul	S	S	S	S	-30	
CARTRIDGE	9C	21 Jul	NO CART IGN	S	S	failed	-40	F4D RH Eng starter breech cap was found bad. F4E LH the Eng shutoff valve failed to open completely
CARTRIDGE	10C	24 Jul	S	S	S	S	-10	Specific gravity to .78
PNEU	10P	24 Jul	S	S	S	S	-10	Ran eng to max RPM before moving throttles
CARTRIDGE	11C	25 Jul	S	S	S	S	-20	ON LH eng we had to use boost [illegible] ejct SW
PNEU	11P	25 JUL	S	S	S	S	-20	

STARTING RESULTS

STARTING MODE	RUN NO.	DATE	F-4D		F-4E		LAB TEMP	
			RH #2	LH #1	RH #2	LH #1		
CARTRIDGE	12C	26 Jul	S	S	S	S	-30	
PNEU	12P	27 Jul			S	S	-30	Mai ground cart failed to start during test on F4D aircraft
CARTRIDGE	13C	27 Jul			S	S	-40	On F4D the cartridge failed to ignite. Electrical problem
PNEU	13P	27 Jul	S	S	S	S	-40	
CARTRIDGE	14C	28 Jul	S	S	S	S	-10	Pulled number 2 C/B
CARTRIDGE	15C	31 Jul	S	S	S	S	-20	
PNEU	15P	31 Jul	S	S	S	S	-20	RH starter breech press, F-4E malfunction ed
CARTRIDGE	16C	1 Aug	S	S	S	S	-30	RH starter breech press, F-4E RF-4D malfunctioned
PNEU	16P	1 Aug	S	S	S	S	-30	Cleaned RH starter breech press Line by blowing air thru them
CARTRIDGE	17C	2 Aug	S	S	S	S	-10	Both LH engine was tested for modified liner RH-HET
PNEU	17P	2 Aug	S	S	S	S	-10	Had another Hyd leak on F-4E aircraft
CARTRIDGE	18C	3 Aug	S	S	S	S	-20	No starter breech press on LH eng. F-4E aircraft
PNEU	18P	3 Aug	S	S	S	S	-20	
CARTRIDGE	19C	4 Aug	S	S	S	S	-30	
CARTRIDGE	20C	7 Aug	S	S	S	S	-10	Using JP-4 with specific gravit at .78
PNEU	20P	7 Aug	S	S	S	S	-10	
CARTRIDGE	21C	8 Aug	S	S	S	S	-20	
PNEU	21P	8 Aug	S	S	S	S	-20	
CARTRIDGE	22C	9 Aug	S	S	S	S	-30	Used boost check switch on LH of F-4D aircraft
PNEU	22P	9 Aug	S	S	S	S	-30	

STARTING RESULTS

Starting Mode	Run No.	Date	F-4D		F-4E		Lab Temp	
			RH #2	LH #3	RH #2	LH #1		
CARTRIDGE	23C	10 Aug.	S	S	S	S	-20	
PNEU	23P	10 Aug	S	S	S	S	-20	
CARTRIDGE	24P	11 Aug	S	S	S	S	-30	Ext. pwr failure- used batter pwr to start the aircraft

S- THE ENGINE SUCCESSFULLY REACHED IDLE RPM

	F-4E				F-4D			
	CART. MODE		PNEU. MODE		CART. MODE		PNEU. MODE	
RUN NO.	LH	RH	LH	RH	LH	RH	LH	RH
1C	--	48			--	37		
1P			--	63			59	60
2C	81	36			51	41		
2P								
3C	51	37			45	40		
3P			57	62			58	48
4C	95	40			47	32		
4P			57	57			52	47
5C	65	36			41	31		
5P			52	54			49	46
6C	95	60			36	36		
7C	39	38			40	38		
7P			59	56			49	50
8C	110	97			79	50		
9C		116			121			
10C	58	48			33	39		
10P			86	97			75	81
11C	44	37			33	34		
11P			49	50			45	44
12C	61	65			43	40		
12P			53	50			53	53
13C	128	113						
13P			72	64			82	63
14C	66	49			34	40		
15C	53	61			45	45		
15P			55	55			48	48
16C	89	100			82	43		
16P			62	59			53	50
17C	60	46			33	41		
17P			52	51			47	46
18C	81	57			43	39		
18P			54	56			50	52
19C	89	87			90	54		
20C	63	39			31	35		
20P			48	56			44	46
21C	39	34			28	32		
21P			45	49			43	42
22C	40	34			28	35		
22P			45	44			40	45
23C	40	34			29	35		
23P			45	47			43	48
24C	47	40			31	39		

C- Cartridge starting mode P- Pneumatic starting mode

TABLE 1 Time to idle in seconds

APPENDIX V

FUEL ANALYSIS - LAB REPORT

F[illegible]EST REPORT

DATE: 23 June 1978

SUBMITTED BY	TEST LABORATORY AND LOCATION	ORIGIN OR CONTRACTOR
[illegible] Eglin AFB, FL 32542	[illegible] LAB [illegible] FL 32544	

LABORATORY TEST NUMBER	78-922					
DATE RECEIVED IN LAB	19 Jun 78					
SPECIFICATION NUMBER	MIL-T-83133					
GRADE NUMBER	JP-8					
CONTRACT NUMBER						
QUANTITY REPRESENTED (GALS)	5,000					
TYPE CONTAINER AND NUMBER	Tank 721986					
SAMPLE NUMBER	78-1217					
REMARKS (PERTAINING TO SAMPLE AS RECEIVED) Date sampled: 13 Jun 78						
LABORATORY DATA						
GRAVITY °A.P.I.	44.7					
WSIM	[illegible]					
APPEARANCE	Clear					
COLOR	Water White					
ODOR	Usual					
WATER REACTION	1 (1)					
FREEZING POINT °F	Below -58					
CORROSION	1a					
EXISTENT GUM, MG/100 ML	6.2					
POTENTIAL GUM, MG/100 ML						
OXIDATION PPT. MG/100 ML						
DOCTOR TEST						
MERCAPTAN SULFUR, % WT.	0.0006					
TOTAL SULFUR, % WT.	0.14					
VAPOR PRESSURE, P.S.I. @ 100° F						
ANILINE POINT °F						
ANILINE GRAVITY CONSTANT OR B.T.U.						
SMOKE POINT MM (OR SMOKE VOL INDEX)						
AROMATICS, %	16.42					
OLEFINS, %	0.7					
TETRAETHYLLEAD ML/GAL						
FLASH POINT, °F	109°F					
KNOCK RATING	LEAN	RICH	LEAN	RICH	LEAN	RICH
TOTAL SOLIDS, MG/GAL (mg/l)	2.8					
FIBROUS MATERIAL PER QT						
VISIBLE FREE WATER ML/GAL	0.0					
NONCOMBUSTIBLE SOLIDS MG/GAL						
TOTAL WATER, PPM BY VOL BY KARL FISCHER						
THERMAL STABILITY, TUBE DEPOSIT CODE NO.	0					
THERMAL STABILITY, PRESSURE DIFF. (IN. HG.)	0					
MIL-I-27686 ICING INHIBITOR, % BY VOL	0.104					
DISTILLATION	IBP °F 306	167 °F	IBP °F	167 °F	IBP °F	167 °F
	10% 336	221	10%	221	10%	221
	20% 347	275	20%	275	20%	275
	40%	290	40%	290	40%	290
	50% 386	370	50%	370	50%	370
	90% 432	400 63.0	90%	400	90%	400
	10% 50%	470	10% 50%	470	10% 50%	470
	E PT. 493	REC 98.0	E PT.	REC	E PT.	REC
	RES % 0.8	LOSS 1.2	RES %	LOSS	RES %	LOSS

REMARKS (PERTAINING TO USABILITY AND DISPOSITION OF MATERIAL)

MATERIAL REPRESENTED BY SAMPLE NO. [illegible] WAS/WAS NOT SATISFACTORY FOR USE

With test fails specification requirements due to ASA 3 anti-static additive. Reference telecon Sgt. White/Z.King @ 1000 EDT, 23 Jun 78.

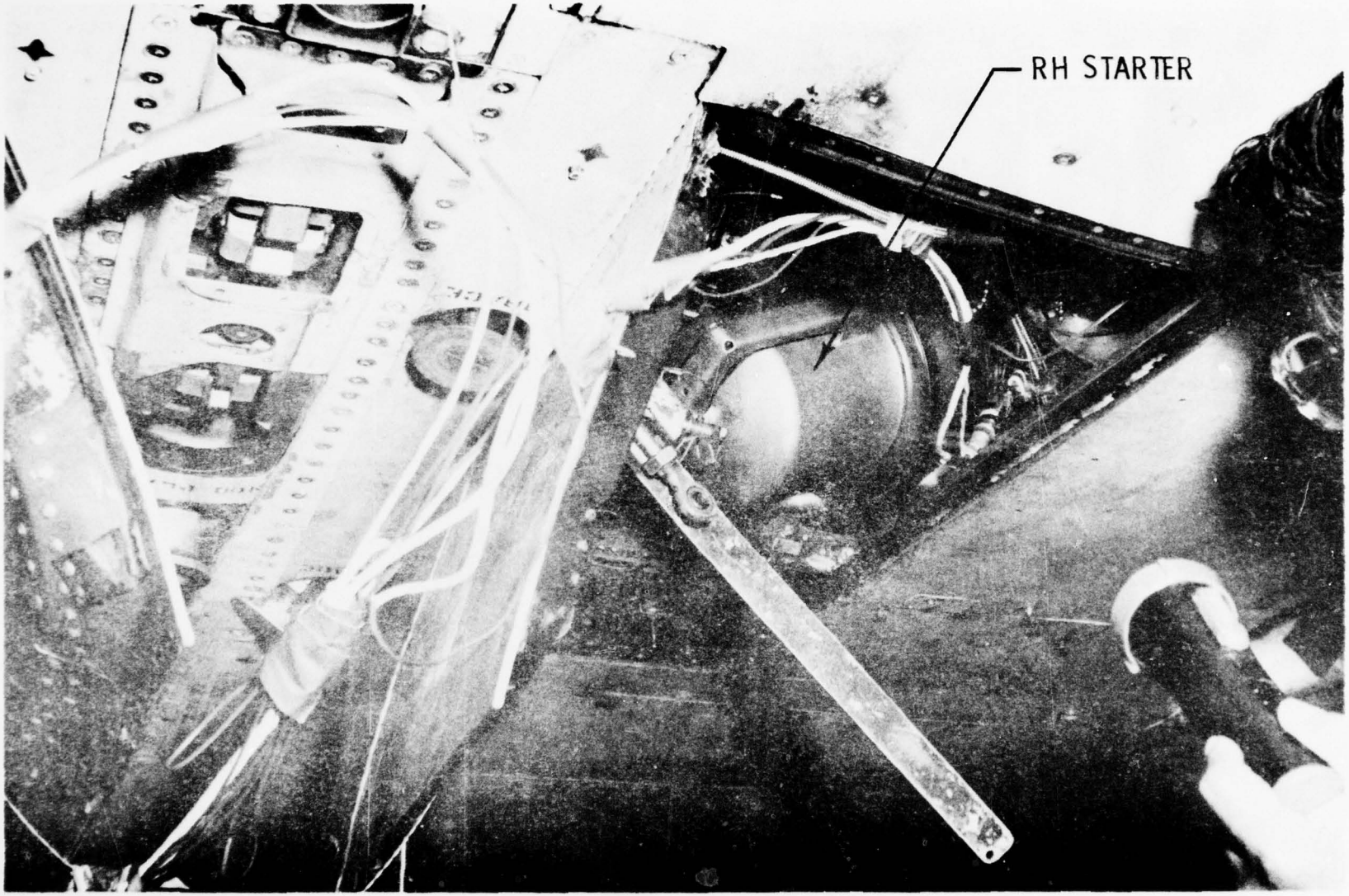
APPROVED BY: (NAME AND SIGNATURE OF LAB SUPV)

[illegible], CHIEF

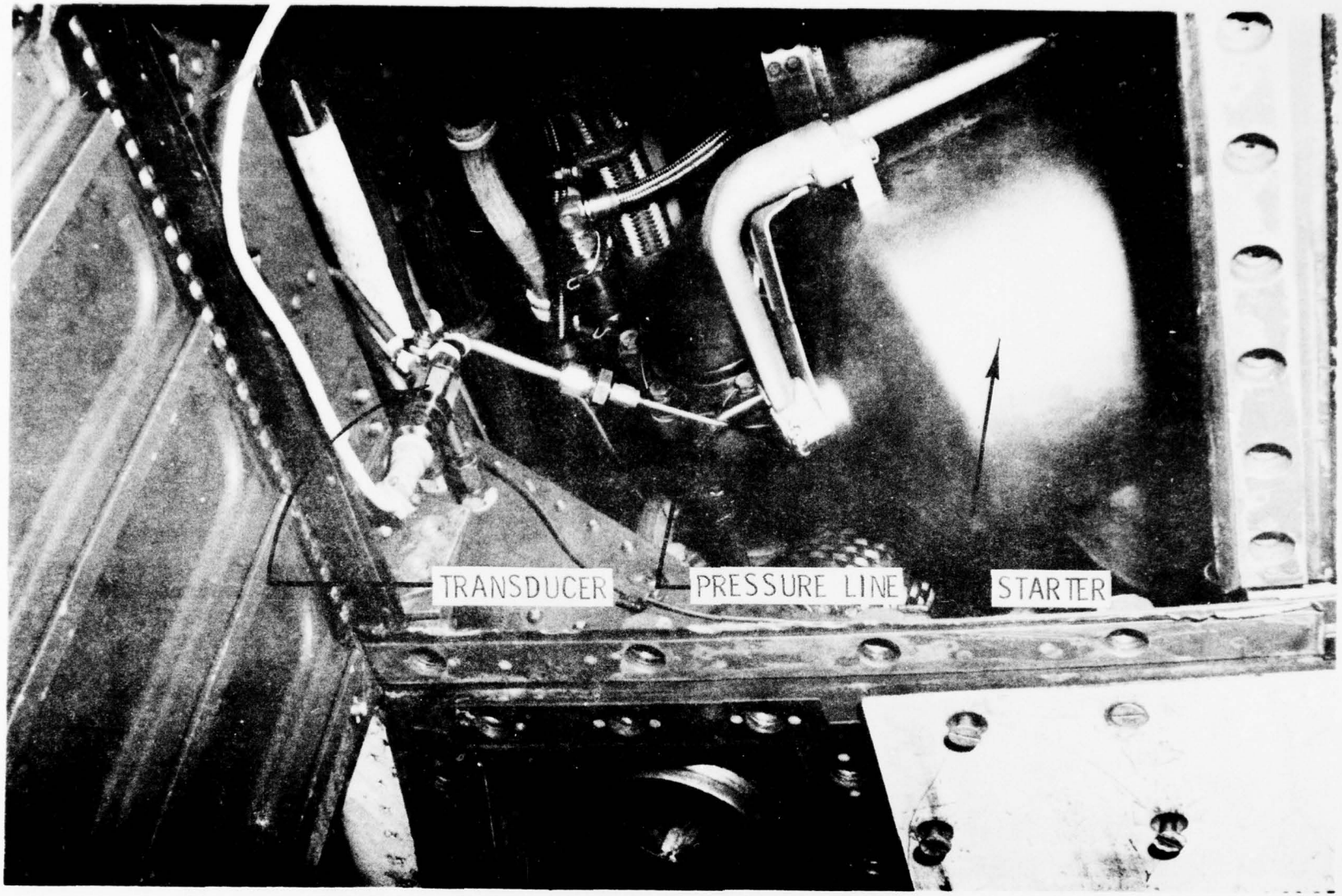
AFTO FORM MAR 77 473 REPLACES AFTO FORM 68, WHICH WILL BE USED

APPENDIX VI

PHOTOS

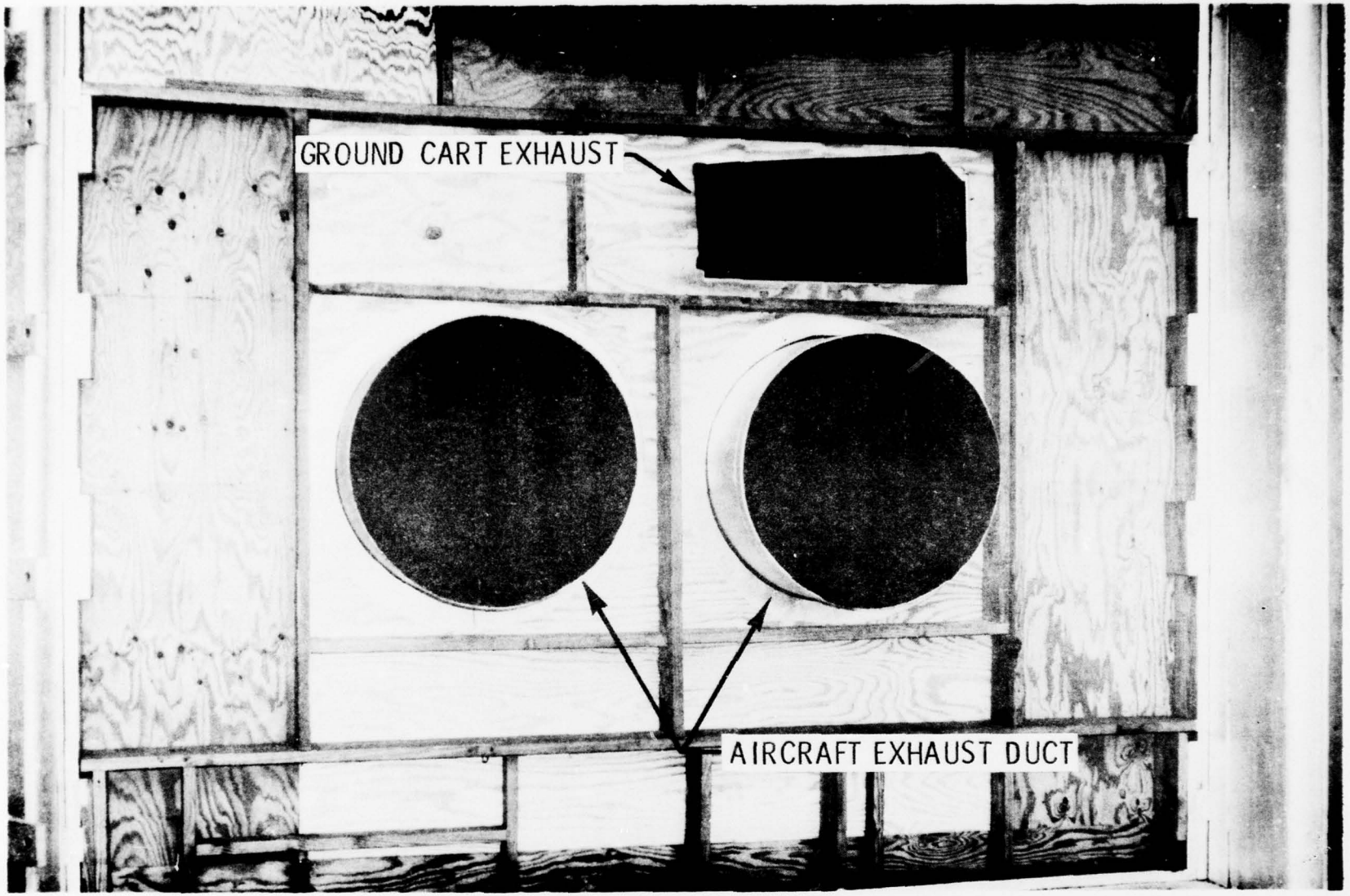


INSTRUMENTATION WIRING

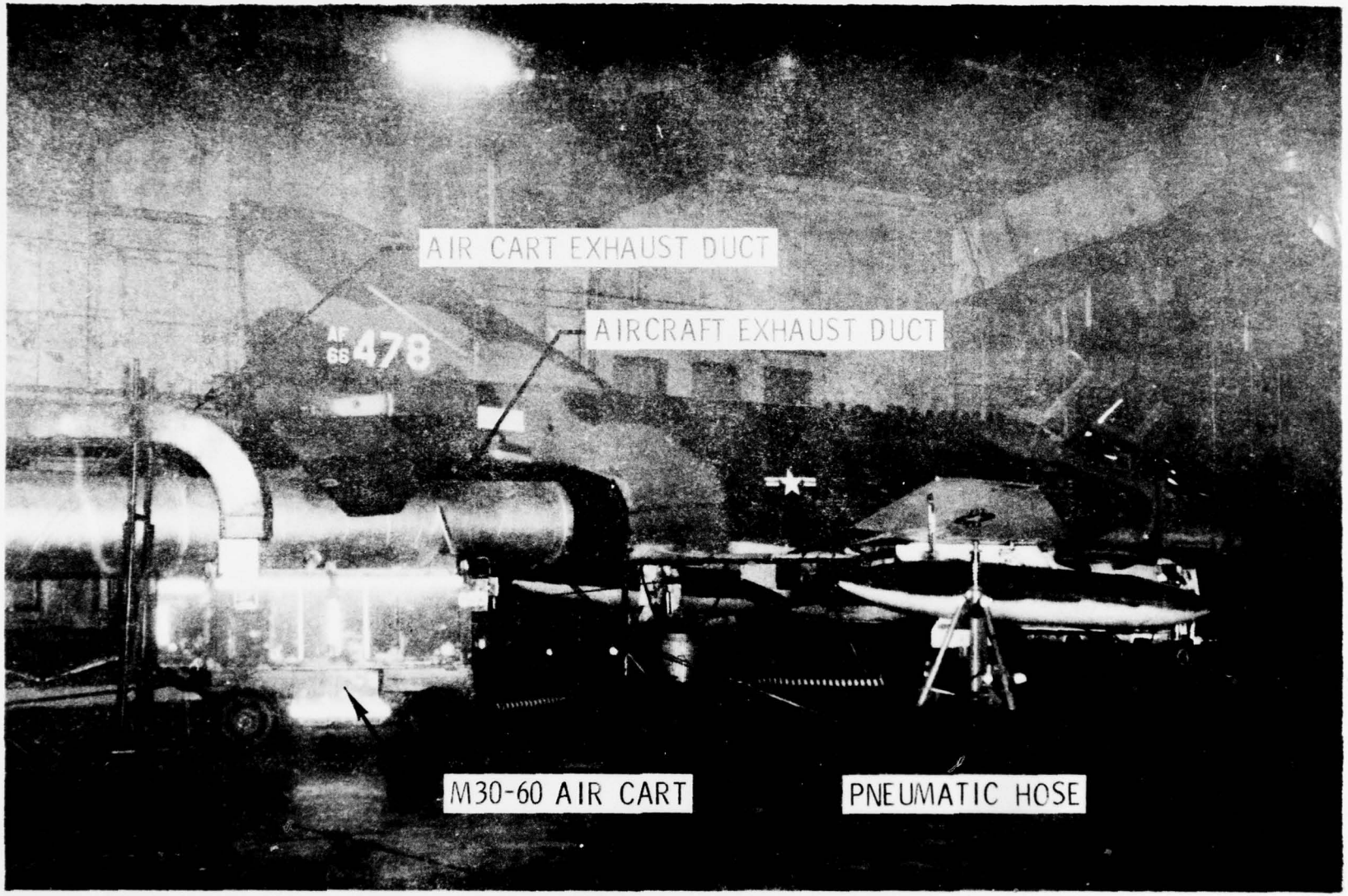


STARTER PRESSURE/SENSING LINE

TEST ENGINEER'S CONTROL BOOTH



OUTSIDE VIEW OF AIRCRAFT & CART EXHAUST DUCTS



POSITIONING OF M32A-60 AIR CART